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(54) Title: BICYCLIC HYDROXAMATES AS INHIBITORS OF MATRIX METALLOPROTEINASES AND/OR TNF- $\alpha$ (A) CONVERTING ENZYME (TACE)

(57) Abstract: The present application describes to novel bicyclic hydroxamates derivatives of formula I: or pharmaceutically acceptable salt or prodrug forms thereof, wherein A, B, B<sup>1</sup>, B<sup>2</sup>, R<sup>1</sup>, and C are defined in the present specification, which are useful as inhibitors of matrix metalloproteinases (MMP), TNF- $\alpha$  converting enzyme (TACE), aggrecanase, or a combination thereof.

## TITLE

BICYCLIC HYDROXAMATES AS INHIBITORS OF MATRIX  
METALLOPROTEINASES AND/OR TNF- $\alpha$  CONVERTING ENZYME (TACE)

5

## FIELD OF THE INVENTION

This invention relates generally to novel bicyclic hydroxamates as inhibitors of matrix metalloproteinases (MMP), TNF- $\alpha$  converting enzyme (TACE), aggrecanase or a  
10 combination thereof, pharmaceutical compositions containing the same, and methods of using the same.

## BACKGROUND OF THE INVENTION

There is now a body of evidence that metalloproteases  
15 (MP) are important in the uncontrolled breakdown of connective tissue, including proteoglycan and collagen, leading to resorption of the extracellular matrix. This is a feature of many pathological conditions, such as rheumatoid and osteoarthritis, corneal, epidermal or  
20 gastric ulceration; tumor metastasis or invasion; periodontal disease and bone disease. Normally these catabolic enzymes are tightly regulated at the level of their synthesis as well as at their level of extracellular activity through the action of specific inhibitors, such as  
25 alpha-2-macroglobulins and TIMPs (tissue inhibitors of metalloprotease), which form inactive complexes with the MP's.

Osteo- and Rheumatoid Arthritis (OA and RA respectively) are destructive diseases of articular  
30 cartilage characterized by localized erosion of the cartilage surface. Findings have shown that articular cartilage from the femoral heads of patients with OA, for

example, had a reduced incorporation of radiolabeled sulfate over controls, suggesting that there must be an enhanced rate of cartilage degradation in OA (Mankin et al. *J. Bone Joint Surg.* **1970**, 52A, 424-434). There are four  
5 classes of protein degradative enzymes in mammalian cells: serine, cysteine, aspartic and metalloproteases. The available evidence supports that it is the metalloproteases that are responsible for the degradation of the extracellular matrix of articular cartilage in OA and RA.  
10 Increased activities of collagenases and stromelysin have been found in OA cartilage and the activity correlates with severity of the lesion (Mankin et al. *Arthritis Rheum.* **1978**, 21, 761-766, Woessner et al. *Arthritis Rheum.* **1983**, 26, 63-68 and Woessner et al. *Arthritis Rheum.* **1984**, 27, 305-312). In addition, aggrecanase has been identified as  
15 providing the specific cleavage product of proteoglycan found in RA and OA patients (Lohmander L.S. et al. *Arthritis Rheum.* **1993**, 36, 1214-22).

Therefore, metalloproteases (MP) have been implicated  
20 as the key enzymes in the destruction of mammalian cartilage and bone. It can be expected that the pathogenesis of such diseases can be modified in a beneficial manner by the administration of MP inhibitors, and many compounds have been suggested for this purpose  
25 (see Wahl et al. *Ann. Rep. Med. Chem.* **1990**, 25, 175-184, AP, San Diego).

Tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) is a cell-associated cytokine that is processed from a 26kd precursor form to a 17kd active form. TNF- $\alpha$  has been shown to be a primary  
30 mediator in humans and in animals, of inflammation, fever, and acute phase responses, similar to those observed during acute infection and shock. Excess TNF- $\alpha$  has been shown to

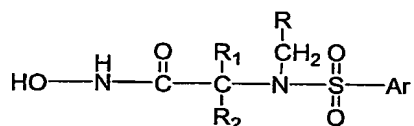
be lethal. There is now considerable evidence that blocking the effects of TNF- $\alpha$  with specific antibodies can be beneficial in a variety of circumstances including autoimmune diseases such as rheumatoid arthritis (Feldman  
5 et al, *Lancet* **1994**, 344, 1105) and non-insulin dependent diabetes melitus. (Lohmander, L.S. et al. *Arthritis Rheum.* **1993**, 36, 1214-22) and Crohn's disease (MacDonald et al. *Clin. Exp. Immunol.* **1990**, 81, 301).

Compounds which inhibit the production of TNF are therefore of therapeutic importance for the treatment of inflammatory disorders. Recently, TNF- $\alpha$  converting enzyme (TACE), the enzyme responsible for TNF- $\alpha$  release from cells, were purified and sequenced (Black et al *Nature* **1997**, 385, 729; Moss et al *Nature* **1997**, 385, 733). This  
15 invention describes molecules that inhibit this enzyme and hence the secretion of active TNF- $\alpha$  from cells. These novel molecules provide a means of mechanism based therapeutic intervention for diseases including but not restricted to septic shock, haemodynamic shock, sepsis  
20 syndrome, post ischemic reperfusion injury, malaria, Crohn's disease, inflammatory bowel diseases, mycobacterial infection, meningitis, psoriasis, congestive heart failure, fibrotic diseases, cachexia, graft rejection, cancer, diseases involving angiogenesis, autoimmune diseases, skin  
25 inflammatory diseases, OA, RA, multiple sclerosis, radiation damage, hyperoxic alveolar injury, periodontal disease, HIV and non-insulin dependent diabetes melitus.

Since excessive TNF- $\alpha$  production has been noted in several disease conditions also characterized by MMP-mediated tissue degradation, compounds which inhibit both  
30 MMPs and TNF- $\alpha$  production may also have a particular advantage in diseases where both mechanisms are involved.

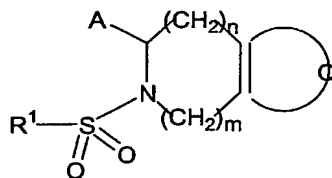
Prostaglandins (PG) play a major role in the inflammation process and the inhibition of PG production has been a common target of anti-inflammatory drug discovery. Many NSAIDS have been found to prevent the production of PG by inhibiting the enzyme cyclooxygenase (COX). Among the two isoforms of COXs, COX-1 is constitutively expressed. COX-2 is an inducible isozyme associated with inflammation. Selective COX-2 inhibitor was believed to maintain the efficacy of traditional NSAIDs, which inhibit both isozymes, and produce fewer and less drastic side effects. As a result, development of selective COX-2 inhibitors has attracted major interest in the pharmaceutical industry. Because of the significant roles of PGs and TNF- $\alpha$  in inflammation, combined use of COX-2 and TACE inhibitors may have superior efficacy to either therapy alone in some inflammatory diseases.

US 5,506,242, US 5,552,419, and US 5,672,615 disclose matrix metalloproteases inhibitors of the formula:



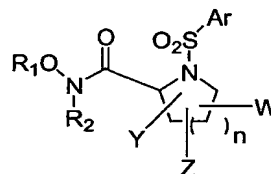
wherein Ar is carbocyclic or heterocyclic aryl; R and R<sub>1</sub> together with the chain to which they are attached form a 1,2,3,4-tetrahydroisoquinoline; R<sub>2</sub> can be hydrogen. The compounds of US 5,506,242, US 5,552,419, and US 5,672,615 are not considered to be part of the presently claimed invention.

WO97/18194 (US 6,207,672) depicts matrix metalloproteases inhibitors of the formula:



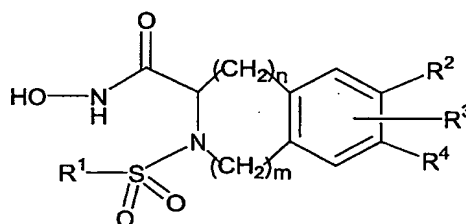
wherein A can be HO-NH-C(O)-; R<sup>1</sup> can be R<sup>2</sup>-X-Ph-B-; X is a bond or a single chain atom spacer; R<sup>2</sup> is unsubstituted or substituted phenyl; and, Q forms a ring as defined in  
 5 WO97/18194. These compounds are not considered to be part of the present invention.

WO98/08850 illustrates matrix metalloproteases inhibitors of the formula:



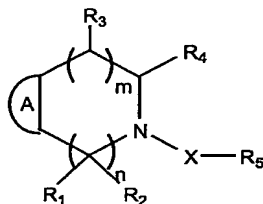
10 wherein R<sub>1</sub> is hydrogen; R<sub>2</sub> can be hydrogen; W can be arylene or heteroarylene bridge between two adjacent carbons forming a fused ring. These compounds are not considered to be part of the present invention.

DE 19542189 presents matrix metalloproteases  
 15 inhibitors of the formula:



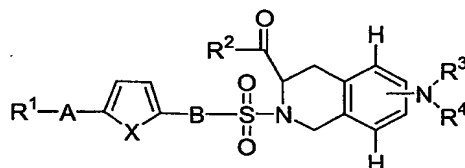
wherein R<sup>1</sup> can be R<sup>5</sup>-X-Ph-A-; A is C<sub>1-4</sub> alkylene or -CH=CH-; X is a bond or a single chain atom spacer. These compounds are not considered to be part of the present  
 20 invention.

US 5,866,587 describes matrix metalloproteases inhibitors of the formula:



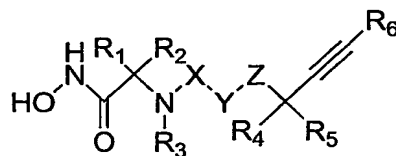
wherein m and n are identical or different, represent 0, 1, 2; A represents an aryl ring or heterocycle; X represents -SO<sub>2</sub>-, -CO-, -SO<sub>2</sub>NH-; and R<sub>5</sub> represents optionally substituted alkyl, (C<sub>3-7</sub>)cycloalkyl, aryl or heterocyclic. These compounds are not considered to be part of the present invention.

US 5,962,471 describes matrix metalloproteases inhibitors of the formula:



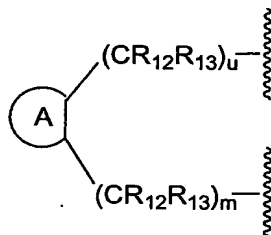
wherein R<sup>1</sup> is unsubstituted or substituted phenyl or heterocycle; A is a bond, O, -CH=CH-, or -C≡C-; B is C<sub>1-3</sub> alkylene, -O-C<sub>1-5</sub> alkylene- or -CH=CH-; X is -CH=CH-, oxygen or sulfur; and R<sup>2</sup> can be HO(H)N-. These compounds are not considered to be part of the present invention.

US 6,225,311 discloses hydroxamic acid derivatives of the formula:



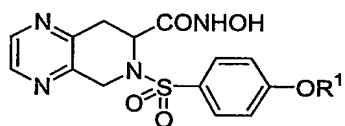
wherein X can be SO<sub>2</sub>; Y is aryl or heteroaryl; Z can be O, NH, CH<sub>2</sub> or S; R<sub>2</sub> can be hydrogen; R<sub>4</sub> and R<sub>5</sub> can be hydrogen;

and  $R_1$  and  $R_3$  together with the atoms to which they are attached can form a divalent moiety of the formula:



wherein A is aryl or heteroaryl. These compounds are defined as being useful as TACE and MMP inhibitors. These compounds are not considered to be part of the present invention.

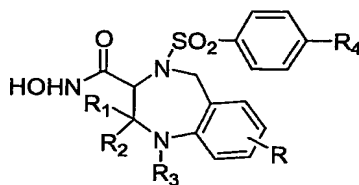
WO00/23443 illustrates TNF- $\alpha$  production inhibitors of the formula:



10

wherein  $R^1$  is an optionally substituted  $C_{1-6}$  alkyl, phenyl, or heteroaryl. These compounds are not considered to be part of the present invention.

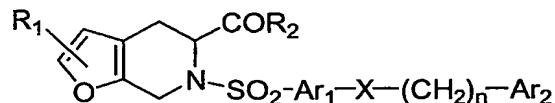
WO00/44730 depicts hydroxamic acid derivatives of the formula:



These compounds are defined as being useful as TACE and MMP inhibitors. These compounds are not considered to be part of the present invention.

EP 1065209 describes matrix metalloproteases inhibitors of the formula:





wherein R<sub>2</sub> can be -NHOH; and Ar<sub>1</sub> can be phenyl. These compounds are not considered to be part of the present invention.

The compounds of the present invention act as inhibitors of MPs, in particular TACE, MMPs, and/or aggrecanase. These novel molecules are provided as anti-inflammatory compounds and cartilage protecting therapeutics. The inhibition of aggrecanase, TACE, and other metalloproteases by molecules of the present invention indicates they are anti-inflammatory and should prevent the degradation of cartilage by these enzymes, thereby alleviating the pathological conditions of OA and RA.

#### SUMMARY OF THE INVENTION

Accordingly, the present invention provides novel bicyclic hydroxamates useful as MMP and/or TACE inhibitors or pharmaceutically acceptable salts or prodrugs thereof.

The present invention provides pharmaceutical compositions comprising a pharmaceutically acceptable carrier and a therapeutically effective amount of at least one of the compounds of the present invention or a pharmaceutically acceptable salt or prodrug form thereof.

The present invention provides a method for treating inflammatory disorders, comprising: administering to a host, in need of such treatment, a therapeutically effective amount of at least one of the compounds of the present invention or a pharmaceutically acceptable salt or prodrug form thereof.

The present invention provides a method of treating a condition or disease mediated by MMPs, TACE, aggrecanase, or a combination thereof in a mammal, comprising:  
administering to the mammal in need of such treatment a  
5 therapeutically effective amount of a compound of the present invention or a pharmaceutically acceptable salt or prodrug form thereof.

The present invention provides a method comprising:  
administering a compound of the present invention or a  
10 pharmaceutically acceptable salt or prodrug form thereof in an amount effective to treat a condition or disease mediated by MMPs, TACE, aggrecanase, or a combination thereof.

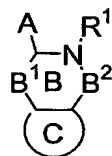
The present invention provides a method for treating  
15 inflammatory disorders, comprising: administering, to a host in need of such treatment, a therapeutically effective amount of one of the compounds of the present invention, in combination with one or more additional anti-inflammatory agents selected from selective COX-2 inhibitors,  
20 interleukin-1 antagonists, dihydroorotate synthase inhibitors, p38 MAP kinase inhibitors, TNF- $\alpha$  inhibitors, TNF- $\alpha$  sequestration agents, and methotrexate.

The present invention provides novel compounds of the present invention for use in therapy.

25 The present invention provides the use of novel compounds of the present invention for the manufacture of a medicament for the treatment of a condition or disease mediated by MMPs, TACE, aggrecanase, or a combination thereof.

30 These and other objects, which will become apparent during the following detailed description, have been

achieved by the inventors' discovery that compounds of formula (I):

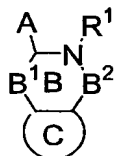


I

- 5 or pharmaceutically acceptable salt or prodrug forms thereof, wherein A, B, B¹, B², R¹, and C are defined below, are effective MMP and/or TACE inhibitors.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

- 10 [1] Thus, in an embodiment, the present invention provides a novel compound of formula I:



I

- 15 or a stereoisomer or pharmaceutically acceptable salt form thereof, wherein;

A is selected from: -C(O)NHOH, -C(O)NHOR<sup>5</sup>, -C(O)NHOR<sup>6</sup>,  
-N(OH)COR<sup>5</sup>, -N(OH)CHO, and -CH<sub>2</sub>SH;

20

ring B, including B¹ and B², is a 5-7 membered heterocyclic ring substituted with 0-1 R²;

- 25 B¹ and B², independently of one another, consist of 0-3 carbon atoms and 0-1 heteroatoms selected from O, N,

and  $S(O)_p$  and are substituted with 0-1 carbonyl groups;

provided that ring B contains other than a N-S, N-O, or N-N  
5 bond;

ring C is a 5-10 membered aromatic ring consisting of 1-9  
carbon atoms and 0-4 heteroatoms selected from O, N,  
and  $S(O)_p$ ;

10

ring C is substituted with 0-1  $R^3$  and 0-1  $R^4$ ;

$R^1$  is U-X-Y-Z- $U^a$ - $X^a$ - $Y^a$ - $Z^a$ ;

15 U is selected from: C(O), C(O)O, C(O)NR<sup>a1</sup>,  $S(O)_p$ , and  
 $S(O)_p$ NR<sup>a1</sup>;

X is absent or is selected from: C<sub>1-10</sub> alkylene, C<sub>2-10</sub>  
alkenylene, and C<sub>2-10</sub> alkynylene;

20

Y is absent or is selected from: O, NR<sup>a1</sup>,  $S(O)_p$ , and C(O);

Z is selected from:

a C<sub>3-13</sub> carbocycle substituted with 0-5  $R^b$ ; and  
25 a 5-14 membered heterocycle consisting of carbon atoms  
and 1-4 heteroatoms selected from the group consisting  
of N, O, and  $S(O)_p$  and substituted with 0-5  $R^b$ ;

$U^a$  is absent or is selected from: O, NR<sup>a1</sup>, C(O), C(O)O,  
30 OC(O), C(O)NR<sup>a1</sup>, NR<sup>a1</sup>C(O), OC(O)O, OC(O)NR<sup>a1</sup>,

$\text{NR}^{\text{a1}}\text{C}(\text{O})\text{O}$ ,  $\text{NR}^{\text{a1}}\text{C}(\text{O})\text{NR}^{\text{a1}}$ ,  $\text{S}(\text{O})_{\text{p}}$ ,  $\text{S}(\text{O})_{\text{p}}\text{NR}^{\text{a1}}$ ,  $\text{NR}^{\text{a1}}\text{S}(\text{O})_{\text{p}}$ ,  
and  $\text{NR}^{\text{a1}}\text{SO}_2\text{NR}^{\text{a1}}$ ;

$\text{X}^{\text{a}}$  is absent or is selected from:  $\text{C}_{1-4}$  alkylene,  $\text{C}_{2-4}$   
5        alkenylene, and  $\text{C}_{2-4}$  alkynylene;

$\text{Y}^{\text{a}}$  is absent or is selected from: O,  $\text{NR}^{\text{a1}}$ ,  $\text{S}(\text{O})_{\text{p}}$ , and  $\text{C}(\text{O})$ ;

provided that  $\text{U}^{\text{a}}-\text{X}^{\text{a}}-\text{Y}^{\text{a}}$  forms a spacer of two or more atoms,  
10        other than  $-\text{CH}=\text{CH}-$  or  $-\text{C}\equiv\text{C}-$ ;

$\text{Z}^{\text{a}}$  is selected from:

a  $\text{C}_{3-13}$  carbocycle substituted with 0-5  $\text{R}^{\text{c}}$ ; and  
a 5-14 membered heterocycle consisting of carbon atoms  
15        and 1-4 heteroatoms selected from the group consisting  
of N, O, and  $\text{S}(\text{O})_{\text{p}}$  and substituted with 0-5  $\text{R}^{\text{c}}$ ;

provided that U, Y, Z,  $\text{U}^{\text{a}}$ ,  $\text{Y}^{\text{a}}$ , and  $\text{Z}^{\text{a}}$  do not combine to  
form a N-N, N-O, O-N, O-O,  $\text{S}(\text{O})_{\text{p}}-\text{O}$ ,  $\text{O}-\text{S}(\text{O})_{\text{p}}$  or  
20         $\text{S}(\text{O})_{\text{p}}-\text{S}(\text{O})_{\text{p}}$  group;

$\text{R}^2$  is selected from: H,  $\text{C}_{1-6}$  alkyl substituted with 0-1  $\text{R}^{\text{b}}$ ,  
 $\text{C}_{2-6}$  alkenyl substituted with 0-1  $\text{R}^{\text{b}}$ , and  $\text{C}_{2-6}$  alkynyl  
substituted with 0-1  $\text{R}^{\text{b}}$ ;

25

$\text{R}^3$  is selected from: H,  $\text{C}_{1-6}$  alkyl substituted with 0-1  $\text{R}^{\text{b}}$ ,  
 $\text{C}_{2-6}$  alkenyl substituted with 0-1  $\text{R}^{\text{b}}$ ,  
 $\text{C}_{2-6}$  alkynyl substituted with 0-1  $\text{R}^{\text{b}}$ ,  
 $\text{C}_{3-10}$  carbocycle substituted with 0-2  $\text{R}^{\text{b}}$ ,  
30         $-(\text{CH}_2)_{\text{r}}-\text{C}_{3-10}$  carbocycle substituted with 0-2  $\text{R}^{\text{b}}$ , and

-(CH<sub>2</sub>)<sub>r</sub>-5-10 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-2 R<sup>b</sup>;

5

R<sup>4</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>b</sup>, C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>b</sup>, C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>b</sup>, OR<sup>a</sup>, Cl, F, Br, I, =O, -CN, NO<sub>2</sub>, NR<sup>a</sup>R<sup>a1</sup>, C(O)R<sup>a</sup>, C(O)OR<sup>a</sup>, C(O)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)R<sup>a</sup>, C(S)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)NR<sup>a</sup>R<sup>a1</sup>, OC(O)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)OR<sup>a</sup>, S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>S(O)<sub>2</sub>R<sup>a3</sup>, NR<sup>a</sup>S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, OS(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>S(O)<sub>2</sub>R<sup>a3</sup>, S(O)<sub>p</sub>R<sup>a3</sup>, CF<sub>3</sub>, OCF<sub>3</sub>, and CF<sub>2</sub>CF<sub>3</sub>;

10

R<sup>a</sup>, at each occurrence, is independently selected from: H and C<sub>1-6</sub> alkyl;

15

R<sup>a1</sup>, at each occurrence, is independently selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>c1</sup>, C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>c1</sup>, C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>c1</sup>, and -(CH<sub>2</sub>)<sub>r</sub>-3-8 membered carbocyclic or heterocyclic ring consisting of carbon atoms and 0-2 ring heteroatoms selected from N, NR<sup>a2</sup>, O, and S(O)<sub>p</sub> and substituted with 0-3 R<sup>c1</sup>;

20

25

alternatively, R<sup>a</sup> and R<sup>a1</sup> when attached to a nitrogen are taken together with the nitrogen to which they are attached form a 5 or 6 membered heterocycle consisting of carbon atoms and from 0-1 additional heteroatoms selected from N, NR<sup>a2</sup>, O, and S(O)<sub>p</sub>;

30

R<sup>a2</sup>, at each occurrence, is independently selected from:

C<sub>1-4</sub> alkyl, phenyl, and benzyl;

- 5 R<sup>a3</sup>, at each occurrence, is independently selected from: H,  
 C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>c1</sup>,  
 C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>c1</sup>,  
 C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>c1</sup>,  
 -(CH<sub>2</sub>)<sub>r</sub>-3-8 membered carbocyclic or heterocyclic ring  
 10 consisting of carbon atoms and 0-2 ring heteroatoms  
 selected from N, NR<sup>a2</sup>, O, and S(O)<sub>p</sub> and substituted  
 with 0-3 R<sup>c1</sup>;

R<sup>b</sup>, at each occurrence, is independently selected from:

- 15 C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>c1</sup>, OR<sup>a</sup>, Cl, F, Br, I,  
 =O, -CN, NO<sub>2</sub>, NR<sup>a</sup>R<sup>a1</sup>, C(O)R<sup>a</sup>, C(O)OR<sup>a</sup>, C(O)NR<sup>a</sup>R<sup>a1</sup>,  
 NR<sup>a</sup>C(O)R<sup>a</sup>, C(S)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)NR<sup>a</sup>R<sup>a1</sup>, OC(O)NR<sup>a</sup>R<sup>a1</sup>,  
 NR<sup>a</sup>C(O)OR<sup>a</sup>, S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>S(O)<sub>2</sub>R<sup>a3</sup>, NR<sup>a</sup>S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>,  
 OS(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>S(O)<sub>2</sub>R<sup>a3</sup>, S(O)<sub>p</sub>R<sup>a3</sup>, CF<sub>3</sub>, OCF<sub>3</sub>, CF<sub>2</sub>CF<sub>3</sub>,  
 20 CHF<sub>2</sub>, CH<sub>2</sub>F, and phenyl;

R<sup>c</sup>, at each occurrence, is independently selected from: H,

- C<sub>1-6</sub> alkyl substituted with 0-2 R<sup>c1</sup>, C<sub>2-6</sub> alkenyl  
 substituted with 0-2 R<sup>c1</sup>, C<sub>2-6</sub> alkynyl substituted  
 25 with 0-2 R<sup>c1</sup>, OR<sup>a</sup>, Cl, F, Br, I, =O, -CN, NO<sub>2</sub>, CF<sub>3</sub>,  
 CF<sub>2</sub>CF<sub>3</sub>, CH<sub>2</sub>F, CHF<sub>2</sub>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>NR<sup>a</sup>R<sup>a1</sup>,  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(=NCN)NR<sup>a</sup>R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(=NR<sup>a</sup>)NR<sup>a</sup>R<sup>a1</sup>,  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(=NOR<sup>a</sup>)NR<sup>a</sup>R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)NR<sup>a</sup>OH,  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)OR<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(S)OR<sup>a1</sup>,

- $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{C}(\text{O})\text{NR}^{\text{a}}\text{Ra}^1$ ,  $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{NR}^{\text{a}}\text{C}(\text{O})\text{Ra}^1$ ,  
 $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{C}(\text{S})\text{NR}^{\text{a}}\text{Ra}^1$ ,  $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{OC}(\text{O})\text{NR}^{\text{a}}\text{Ra}^1$ ,  
 $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{NR}^{\text{a}}\text{C}(\text{O})\text{ORa}^1$ ,  $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{NR}^{\text{a}}\text{C}(\text{O})\text{NR}^{\text{a}}\text{Ra}^1$ ,  
 $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{S}(\text{O})_p\text{Ra}^3$ ,  $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{SO}_2\text{NR}^{\text{a}}\text{Ra}^1$ ,  $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{NR}^{\text{a}}\text{SO}_2\text{Ra}^3$ ,  
5  $(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{NR}^{\text{a}}\text{SO}_2\text{NR}^{\text{a}}\text{Ra}^1$ ,  
 $-(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{-C}_{3-10}$  carbocycle substituted with 0-2  $\text{R}^{\text{c}1}$ ,  
and  
 $-(\text{CR}^{\text{a}}\text{Ra}^1)_n\text{-5-14}$  membered heterocycle consisting of  
carbon atoms and 1-4 heteroatoms selected from the  
10 group consisting of N, O, and  $\text{S}(\text{O})_p$  and substituted  
with 0-2  $\text{R}^{\text{c}1}$ ;  
  
 $\text{R}^{\text{c}1}$ , at each occurrence, is independently selected from: H,  
 $\text{C}_{1-4}$  alkyl,  $\text{OR}^{\text{a}}$ , Cl, F, Br, I, =O,  $\text{CF}_3$ , -CN,  $\text{NO}_2$ ,  
15  $\text{C}(\text{O})\text{R}^{\text{a}}$ ,  $\text{C}(\text{O})\text{OR}^{\text{a}}$ ,  $\text{C}(\text{O})\text{NR}^{\text{a}}\text{Ra}^1$ , and  $\text{S}(\text{O})_p\text{Ra}^1$ ;  
  
 $\text{R}^5$ , at each occurrence, is selected from:  $\text{C}_{1-10}$  alkyl  
substituted with 0-2  $\text{R}^{\text{b}}$ , and  $\text{C}_{1-8}$  alkyl substituted  
with 0-2  $\text{R}^{\text{e}}$ ;  
20  
 $\text{R}^{\text{e}}$ , at each occurrence, is selected from: phenyl  
substituted with 0-2  $\text{R}^{\text{b}}$  and biphenyl substituted with  
0-2  $\text{R}^{\text{b}}$ ;  
  
25  $\text{R}^6$ , at each occurrence, is selected from: phenyl, naphthyl,  
 $\text{C}_{1-10}$  alkyl-phenyl- $\text{C}_{1-6}$  alkyl-,  $\text{C}_{3-11}$  cycloalkyl,  $\text{C}_{1-6}$   
alkylcarbonyloxy- $\text{C}_{1-3}$  alkyl-,  $\text{C}_{1-6}$   
alkoxycarbonyloxy- $\text{C}_{1-3}$  alkyl-,  $\text{C}_{2-10}$  alkoxy carbonyl,  
 $\text{C}_{3-6}$  cycloalkylcarbonyloxy- $\text{C}_{1-3}$  alkyl-,  $\text{C}_{3-6}$   
30 cycloalkoxy carbonyloxy- $\text{C}_{1-3}$  alkyl-,  $\text{C}_{3-6}$



- cycloalkoxycarbonyl, phenoxycarbonyl,  
 phenyloxycarbonyloxy-C<sub>1-3</sub> alkyl-,  
 phenylcarbonyloxy-C<sub>1-3</sub> alkyl-, C<sub>1-6</sub> alkoxy-C<sub>1-6</sub>  
 alkylcarbonyloxy-C<sub>1-3</sub> alkyl-, [5-(C<sub>1</sub>-C<sub>5</sub>  
 5 alkyl)-1,3-dioxo-cyclopenten-2-one-yl]methyl,  
 [5-(R<sup>a</sup>)-1,3-dioxo-cyclopenten-2-one-yl]methyl,  
 (5-aryl-1,3-dioxo-cyclopenten-2-one-yl)methyl, -C<sub>1-10</sub>  
 alkyl-NR<sup>7</sup>R<sup>7a</sup>, -CH(R<sup>8</sup>)OC(=O)R<sup>9</sup>, and -CH(R<sup>8</sup>)OC(=O)OR<sup>9</sup>;
- 10 R<sup>7</sup> is selected from: H, C<sub>1-10</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>3-6</sub>  
 cycloalkyl-C<sub>1-3</sub> alkyl-, and phenyl-C<sub>1-6</sub> alkyl-;
- R<sup>7a</sup> is selected from H, C<sub>1-10</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>3-6</sub>  
 cycloalkyl-C<sub>1-3</sub> alkyl-, and phenyl-C<sub>1-6</sub> alkyl-;
- 15 R<sup>8</sup> is selected from H and C<sub>1-4</sub> linear alkyl;
- R<sup>9</sup> is selected from H, C<sub>1-8</sub> alkyl substituted with 1-2 R<sup>f</sup>,  
 C<sub>3-8</sub> cycloalkyl substituted with 1-2 R<sup>f</sup>, and phenyl  
 20 substituted with 0-2 R<sup>b</sup>;
- R<sup>f</sup>, at each occurrence, is selected from: C<sub>1-4</sub> alkyl, C<sub>3-8</sub>  
 cycloalkyl, C<sub>1-5</sub> alkoxy, and phenyl substituted with  
 0-2 R<sup>b</sup>;
- 25 n, at each occurrence, is selected from: 0, 1, 2, 3, and 4;
- p, at each occurrence, is selected from: 0, 1, and 2; and
- 30 r, at each occurrence, is selected from: 0, 1, 2, 3, and 4;

provided that:

- (i) when rings B and C form tetrahydroisoquinoline and A is  $-C(O)NHOH$ , then  $R^1$  is other than {4-  
 5 ((2-methyl-4-quinolinyl)methoxy)phenyl}acetyl,  
 {(2-hydroxybenzoyl)amino}benzenesulfonyl,  
 {(4-fluorophenyl)methoxy}benzenesulfonyl, or  
 {(4-methoxyphenyl)carbamate}benzenesulfonyl;
- (ii) when rings B and C form tetrahydro-furo[2,3-  
 10 c]pyridine, A is  $-C(O)NHOH$ , and U is  $SO_2$ , then  
 Z is other than phenyl;
- (iii) when rings B and C form tetrahydro-1H-  
 [1,4]benzodiazepine, A is  $-C(O)NHOH$ , U is  $SO_2$ ,  
 then Z is other than phenyl;
- (iv) when U is  $SO_2$ , then  $U^a-X^a-Y^a$  is other than  
 15  $-OCH_2-C\equiv C-$ ,  $-NHCH_2-C\equiv C-$ ,  $-CH_2CH_2-C\equiv C-$  or  
 $-SCH_2-C\equiv C-$ ;
- (v) when U is  $SO_2$  and Z is phenyl, then  $U^a$  is other  
 than  $OC(O)$ .

20

[2] In another embodiment, the present invention provides  
 a novel compound, wherein;

25 A is selected from:  $-C(O)NHOH$ ,  $-C(O)NHOR^5$ ,  $-C(O)NHOR^6$ ,  
 $-N(OH)COR^5$ , and  $-N(OH)CHO$ ;

ring B including  $B^1$  and  $B^2$  is a 5-6 membered heterocyclic  
 ring substituted with 0-1  $R^2$ ;

30

ring C is a 6 membered aryl or 5-6 membered heteroaryl  
consisting of 1-6 carbon atoms and 0-4 heteroatoms  
selected from O, N, and S(O)<sub>p</sub>;

5 ring C is substituted with 0-1 R<sup>3</sup> and 0-1 R<sup>4</sup>;

X is absent or is selected from: C<sub>1-4</sub> alkylene, C<sub>2-4</sub>  
alkenylene, and C<sub>2-4</sub> alkynylene;

10 Y is absent;

Z is selected from:

a C<sub>3-11</sub> carbocycle substituted with 0-5 R<sup>b</sup>; and  
a 5-11 membered heterocycle consisting of carbon atoms  
15 and 1-4 heteroatoms selected from the group consisting  
of N, O, and S(O)<sub>p</sub> and substituted with 0-5 R<sup>b</sup>;

U<sup>a</sup> is absent or is selected from: O, NR<sup>a1</sup>, C(O), C(O)O,  
C(O)NR<sup>a1</sup>, NR<sup>a1</sup>C(O), S(O)<sub>p</sub>, and S(O)<sub>p</sub>NR<sup>a1</sup>;

20

X<sup>a</sup> is absent or is selected from: C<sub>1-4</sub> alkylene, C<sub>2</sub>  
alkenylene, and C<sub>2</sub> alkynylene;

Y<sup>a</sup> is absent or is selected from: O and NR<sup>a1</sup>;

25

provided that U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup> forms a spacer of two or more atoms,  
other than -CH=CH- or -C≡C-;

Z<sup>a</sup> is selected from:

30 a C<sub>3-13</sub> carbocycle substituted with 0-5 R<sup>c</sup>; and

a 5-10 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-5 R<sup>c</sup>;

5 provided that U, Z, U<sup>a</sup>, Y<sup>a</sup>, and Z<sup>a</sup> do not combine to form a N-N, N-O, O-N, O-O, S(O)<sub>p</sub>-O, O-S(O)<sub>p</sub> or S(O)<sub>p</sub>-S(O)<sub>p</sub> group;

R<sup>3</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>b</sup>,  
10 C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>b</sup>,  
C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>b</sup>,  
C<sub>3-6</sub> carbocycle substituted with 0-2 R<sup>b</sup>,  
-CH<sub>2</sub>-C<sub>3-6</sub> carbocycle substituted with 0-2 R<sup>b</sup>,  
a 5-6 membered heterocycle consisting of carbon atoms  
15 and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-2 R<sup>b</sup>, and  
-CH<sub>2</sub>-5-6 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-2  
20 R<sup>b</sup>;

R<sup>a</sup>, at each occurrence, is independently selected from: H and C<sub>1-4</sub> alkyl;

25 R<sup>a1</sup>, at each occurrence, is independently selected from: H, C<sub>1-4</sub> alkyl, phenyl and benzyl;

alternatively, R<sup>a</sup> and R<sup>a1</sup> when attached to a nitrogen are taken together with the nitrogen to which they are  
30 attached form a 5 or 6 membered heterocycle consisting

of carbon atoms and from 0-1 additional heteroatoms selected from N,  $\text{NR}^{\text{a}2}$ , O, and  $\text{S}(\text{O})_{\text{p}}$ ;

$\text{R}^{\text{b}}$ , at each occurrence, is independently selected from:

5  $\text{C}_{1-6}$  alkyl,  $\text{OR}^{\text{a}}$ , Cl, F, Br, =O, -CN,  $\text{NR}^{\text{a}1}$ ,  $\text{C}(\text{O})\text{R}^{\text{a}}$ ,  $\text{C}(\text{O})\text{OR}^{\text{a}}$ ,  $\text{C}(\text{O})\text{NR}^{\text{a}1}$ ,  $\text{NR}^{\text{a}}\text{C}(\text{O})\text{R}^{\text{a}}$ ,  $\text{S}(\text{O})_2\text{NR}^{\text{a}1}$ ,  $\text{S}(\text{O})_{\text{p}}\text{R}^{\text{a}3}$ ,  $\text{CF}_3$ , and  $\text{OCF}_3$ ;

$\text{R}^{\text{c}}$ , at each occurrence, is independently selected from:

10  $\text{C}_{1-6}$  alkyl substituted with 0-1  $\text{R}^{\text{c}1}$ ,  $\text{C}_{2-6}$  alkenyl substituted with 0-1  $\text{R}^{\text{c}1}$ ,  $\text{C}_{2-6}$  alkynyl substituted with 0-1  $\text{R}^{\text{c}1}$ ,  $\text{OR}^{\text{a}}$ , Cl, F, Br, =O, -CN,  $\text{NR}^{\text{a}1}$ ,  $\text{CF}_3$ ,  $(\text{CR}^{\text{a}1})_{\text{n}}\text{C}(\text{O})\text{R}^{\text{a}1}$ ,  $(\text{CR}^{\text{a}1})_{\text{n}}\text{C}(\text{O})\text{OR}^{\text{a}1}$ ,  $(\text{CR}^{\text{a}1})_{\text{n}}\text{C}(\text{O})\text{NR}^{\text{a}1}$ ,  $(\text{CR}^{\text{a}1})_{\text{n}}\text{S}(\text{O})_{\text{p}}\text{R}^{\text{a}3}$ ,  $(\text{CR}^{\text{a}1})_{\text{n}}\text{SO}_2\text{NR}^{\text{a}1}$ ,  $\text{C}_{3-6}$  carbocycle  
15 and a 5-6 membered heterocycle comprising carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and  $\text{S}(\text{O})_{\text{p}}$ ;

$\text{R}^5$ , at each occurrence, is selected from:  $\text{C}_{1-6}$  alkyl

20 substituted with 0-2  $\text{R}^{\text{b}}$ , and  $\text{C}_{1-4}$  alkyl substituted with 0-2  $\text{R}^{\text{e}}$ ;

$\text{R}^7$  is selected from: H,  $\text{C}_{1-6}$  alkyl,  $\text{C}_{2-6}$  alkenyl,  $\text{C}_{3-6}$  cycloalkyl- $\text{C}_{1-3}$  alkyl-, and phenyl- $\text{C}_{1-6}$  alkyl-;

25

$\text{R}^{7\text{a}}$  is selected from: H,  $\text{C}_{1-6}$  alkyl,  $\text{C}_{2-6}$  alkenyl,  $\text{C}_{3-6}$  cycloalkyl- $\text{C}_{1-3}$  alkyl-, and phenyl- $\text{C}_{1-6}$  alkyl-; and

R<sup>9</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 1-2 R<sup>f</sup>,  
C<sub>3-6</sub> cycloalkyl substituted with 1-2 R<sup>f</sup>, and phenyl  
substituted with 0-2 R<sup>b</sup>;

5 provided that:

- (i) when rings B and C form tetrahydroisoquinoline  
and A is -C(O)NHOH, then R<sup>1</sup> is other than {4-  
{(2-methyl-4-quinolinyl)methoxy}phenyl}acetyl,  
{(2-hydroxybenzoyl)amino}benzenesulfonyl,  
10 {(4-fluorophenyl)methoxy}benzenesulfonyl, or  
{(4-methoxyphenyl)carbamate}benzenesulfonyl;  
(ii) when rings B and C form tetrahydro-furo[2,3-  
c]pyridine, A is -C(O)NHOH, and U is SO<sub>2</sub>, then  
Z is other than phenyl.

15

[3] In another embodiment, the present invention provides  
a novel compound, wherein;

20 A is selected from: -C(O)NHOH, and -N(OH)CHO;

U-X is SO<sub>2</sub>, C(O), or C(O)CH<sub>2</sub>;

Z is phenyl substituted with 0-3 R<sup>b</sup> or pyridyl substituted  
25 with 0-3 R<sup>b</sup>;

U<sup>a</sup> is absent or is selected from: O, NR<sup>a1</sup>, C(O), C(O)NR<sup>a1</sup>,  
S(O)<sub>p</sub>, and S(O)<sub>p</sub>NR<sup>a1</sup>;

30 X<sup>a</sup> is absent or is selected from: C<sub>1-4</sub> alkylene, C<sub>2</sub>  
alkenylene, and C<sub>2</sub> alkynylene;

provided that  $U^a-X^a-Y^a$  forms a spacer of two or more atoms and is other than  $-CH=CH-$  or  $-C\equiv C-$ ;

- 5  $Z^a$  is a  $C_{5-6}$  carbocycle substituted with 0-3  $R^c$  or a 5-10 membered heteroaryl containing from 1-4 heteroatoms selected from the group consisting of N, O, and  $S(O)_p$  and substituted with 0-3  $R^c$ ;
- 10 provided that Z,  $U^a$ ,  $Y^a$ , and  $Z^a$  do not combine to form a N-N, N-O, O-N, O-O,  $S(O)_p-O$ ,  $O-S(O)_p$  or  $S(O)_p-S(O)_p$  group;

- $R^a$ , at each occurrence, is independently selected from: H  
15 and  $C_{1-4}$  alkyl;

$R^{a1}$ , at each occurrence, is independently selected from: H,  $C_{1-4}$  alkyl, phenyl and benzyl;

- 20  $R^b$ , at each occurrence, is independently selected from:  $C_{1-4}$  alkyl,  $OR^a$ , Cl, F, =O,  $NR^aR^{a1}$ ,  $C(O)R^a$ ,  $C(O)OR^a$ ,  $C(O)NR^aR^{a1}$ ,  $S(O)_2NR^aR^{a1}$ ,  $S(O)_pR^{a3}$ , and  $CF_3$ ;

- $R^c$ , at each occurrence, is independently selected from:  
25  $C_{1-6}$  alkyl,  $C_{2-6}$  alkenyl,  $C_{2-6}$  alkynyl,  $OR^a$ , Cl, F, Br, =O,  $NR^aR^{a1}$ ,  $CF_3$ ,  $(CR^aR^{a1})_nC(O)R^{a1}$ ,  $(CR^aR^{a1})_nC(O)OR^a$ ,  $(CR^aR^{a1})_nC(O)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nS(O)_pR^{a3}$ ,  $(CR^aR^{a1})_nSO_2NR^aR^{a1}$ , and phenyl; and

R<sup>5</sup>, at each occurrence, is selected from: C<sub>1-4</sub> alkyl substituted with 0-2 R<sup>b</sup>, and C<sub>1-4</sub> alkyl substituted with 0-2 R<sup>e</sup>;

5 provided that:

- (i) when rings B and C form tetrahydroisoquinoline and A is -C(O)NHOH, then R<sup>1</sup> is other than {4-((2-methyl-4-quinolinyl)methoxy)phenyl}acetyl, {(2-hydroxybenzoyl)amino}benzenesulfonyl or  
10 {(4-fluorophenyl)methoxy}benzenesulfonyl;
- (ii) when rings B and C form tetrahydro-furo[2,3-c]pyridine, A is -C(O)NHOH, and U is SO<sub>2</sub>, then Z is other than phenyl.

15

[4] In another embodiment, the present invention provides a novel compound, wherein;

A is -C(O)NHOH;

20

Z is phenyl substituted with 0-1 R<sup>b</sup> or pyridyl substituted with 0-1 R<sup>b</sup>;

U<sup>a</sup> is absent or is O;

25

X<sup>a</sup> is absent or is CH<sub>2</sub> or CH<sub>2</sub>CH<sub>2</sub>;

Y<sup>a</sup> is absent or is O;

30 provided that U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup> forms a spacer of two or more atoms, other than -CH=CH- or -C≡C-;



Z<sup>a</sup> is selected from: phenyl substituted with 0-3 R<sup>c</sup>,  
 pyridyl substituted with 0-3 R<sup>c</sup>, and quinolinyl  
 substituted with 0-3 R<sup>c</sup>;

5

provided that Z, U<sup>a</sup>, Y<sup>a</sup>, and Z<sup>a</sup> do not combine to form a  
 N-N, N-O, O-N, or O-O group;

R<sup>a</sup>, at each occurrence, is independently selected from: H,  
 10 CH<sub>3</sub>, and CH<sub>2</sub>CH<sub>3</sub>;

R<sup>a1</sup>, at each occurrence, is independently selected from: H,  
 CH<sub>3</sub>, and CH<sub>2</sub>CH<sub>3</sub>;

15 R<sup>a2</sup>, at each occurrence, is independently selected from: H,  
 CH<sub>3</sub>, and CH<sub>2</sub>CH<sub>3</sub>;

R<sup>c</sup>, at each occurrence, is independently selected from:  
 C<sub>1-6</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>2-6</sub> alkynyl, OR<sup>a</sup>, Cl, F, Br,  
 20 =O, NR<sup>a</sup>R<sup>a1</sup>, CF<sub>3</sub>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)OR<sup>a</sup>,  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)NR<sup>a</sup>R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>S(O)<sub>p</sub>R<sup>a3</sup>, and  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>SO<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>;

r, at each occurrence, is selected from 0, 1, 2, and 3;  
 25 and,

n, at each occurrence, is selected from 0, 1, 2, and 3;

provided that:

30 (i) when rings B and C form tetrahydroisoquinoline  
 and A is -C(O)NHOH, then R<sup>1</sup> is other than {4-

((2-methyl-4-quinolinyl)methoxy)phenyl}acetyl  
or {(4-fluorophenyl)methoxy}benzenesulfonyl;  
(ii) when rings B and C form tetrahydro-furo[2,3-  
c]pyridine, A is -C(O)NHOH, and U is SO<sub>2</sub>, then  
5 Z is other than phenyl.

[5] In another embodiment, the present invention provides  
a novel compound selected from the group:

10

N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
acetyl)-5,6,7,8-tetrahydro-1,6-naphthyridine-7-  
carboxamide;

15

N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
sulfonyl)-5,6,7,8-tetrahydro-1,6-naphthyridine-7-  
carboxamide;

20

N-hydroxy-7-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
acetyl)-5,6,7,8-tetrahydro-1,7-naphthyridine-6-  
carboxamide;

25

N-hydroxy-7-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
sulfonyl)-5,6,7,8-tetrahydro-1,7-naphthyridine-6-  
carboxamide;

30

N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
acetyl)-5,6,7,8-tetrahydropyrido[3,4-b]-pyrazine-7-  
carboxamide;

- N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl)sulfonyl)-5,6,7,8-tetrahydropyrido[3,4-b]pyrazine-7-carboxamide;
- 5 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}acetyl)-4,5,6,7-tetrahydro[1,3]oxazolo[5,4-c]pyridine-6-carboxamide;
- 10 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}sulfonyl)-4,5,6,7-tetrahydro[1,3]oxazolo[5,4-c]pyridine-6-carboxamide;
- 15 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}acetyl)-4,5,6,7-tetrahydro[1,3]thiazolo[4,5-c]pyridine-6-carboxamide; and
- 20 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}sulfonyl)-4,5,6,7-tetrahydro[1,3]thiazolo[4,5-c]pyridine-6-carboxamide;
- or a pharmaceutically acceptable salt form thereof.

In another embodiment, the present invention provides a novel pharmaceutical composition, comprising: a  
25 pharmaceutically acceptable carrier and a therapeutically effective amount of a compound of the present invention or a pharmaceutically acceptable salt form thereof.

In another embodiment, the present invention provides  
30 a novel method for treating an inflammatory disorder, comprising: administering to a patient in need thereof a therapeutically effective amount of a compound of the

present invention or a pharmaceutically acceptable salt form thereof.

In another embodiment, the present invention provides  
5 a novel method of treating a condition or disease mediated by MMPs, TACE, aggrecanase, or a combination thereof in a mammal, comprising: administering to the mammal in need of such treatment a therapeutically effective amount of a compound of the present invention or a pharmaceutically  
10 acceptable salt form thereof.

In another embodiment, the present invention provides a novel method comprising: administering a compound of the present invention or a pharmaceutically acceptable salt  
15 form thereof in an amount effective to treat a condition or disease mediated by MMPs, TACE, aggrecanase, or a combination thereof.

In another embodiment, the present invention provides  
20 a novel method of treating a disease or condition selected from acute infection, acute phase response, age related macular degeneration, alcoholic liver disease, allergy, allergic asthma, anorexia, aneurism, aortic aneurism, asthma, atherosclerosis, atopic dermatitis, autoimmune  
25 disease, autoimmune hepatitis, Bechet's disease, cachexia, calcium pyrophosphate dihydrate deposition disease, cardiovascular effects, chronic fatigue syndrome, chronic obstruction pulmonary disease, coagulation, congestive heart failure, corneal ulceration, Crohn's disease,  
30 enteropathic arthropathy, Felty's syndrome, fever, fibromyalgia syndrome, fibrotic disease, gingivitis, glucocorticoid withdrawal syndrome, gout, graft versus host

disease, hemorrhage, HIV infection, hyperoxic alveolar injury, infectious arthritis, inflammation, intermittent hydrarthrosis, Lyme disease, meningitis, multiple sclerosis, myasthenia gravis, mycobacterial infection, 5 neovascular glaucoma, osteoarthritis, pelvic inflammatory disease, periodontitis, polymyositis/dermatomyositis, post-ischaemic reperfusion injury, post-radiation asthenia, psoriasis, psoriatic arthritis, pulmonary emphysema, pyoderma gangrenosum, relapsing polychondritis, Reiter's 10 syndrome, rheumatic fever, rheumatoid arthritis, sarcoidosis, scleroderma, sepsis syndrome, Still's disease, shock, Sjogren's syndrome, skin inflammatory diseases, solid tumor growth and tumor invasion by secondary metastases, spondylitis, stroke, systemic lupus 15 erythematosus, ulcerative colitis, uveitis, vasculitis, and Wegener's granulomatosis.

In another embodiment, the present invention provides novel compounds of the present invention for use in 20 therapy.

In another embodiment, the present invention provides the use of novel compounds of the present invention for the manufacture of a medicament for the treatment of a 25 condition or disease mediated by MMPs, TACE, aggrecanase, or a combination thereof.

In another embodiment, the present invention provides a novel article of manufacture, comprising:

- 30 (a) a first container;
- (b) a pharmaceutical composition located within the first container, wherein the composition, comprises: a

first therapeutic agent, comprising: a compound of the present invention or a pharmaceutically acceptable salt form thereof; and,

(c) a package insert stating that the pharmaceutical composition can be used for the treatment of an inflammatory disorder.

In another embodiment, the present invention provides a novel article of manufacture, comprising:

(a) a first container;  
(b) a pharmaceutical composition located within the first container, wherein the composition, comprises: a first therapeutic agent, comprising: a compound of the present invention or a pharmaceutically acceptable salt form thereof; and,

(c) a package insert stating that the pharmaceutical composition can be used in combination with a second therapeutic agent to treat an inflammatory disorder.

In another preferred embodiment, the present invention provides a novel article of manufacture, further comprising:

(d) a second container;  
wherein components (a) and (b) are located within the second container and component (c) is located within or outside of the second container.

In another embodiment, the present invention provides a method for treating inflammatory disorders, comprising: administering, to a host in need of such treatment, a therapeutically effective amount of one of the compounds of the present invention, in combination with one or more

additional anti-inflammatory agents selected from selective COX-2 inhibitors, interleukin-1 antagonists, dihydroorotate synthase inhibitors, p38 MAP kinase inhibitors, TNF- $\alpha$  inhibitors, TNF- $\alpha$  sequestration agents, and methotrexate.

5

This invention also encompasses all combinations of preferred aspects of the invention noted herein. It is understood that any and all embodiments of the present invention may be taken in conjunction with any other  
10 embodiment to describe additional even more preferred .  
embodiments of the present invention. It is also understood that each and every element of any embodiment is intended to be a separate specific embodiment.  
Furthermore, any elements of an embodiment are meant to be  
15 combined with any and all other elements from any of the  
embodiments to describe additional embodiments.

#### DEFINITIONS

The compounds herein described may have asymmetric  
20 centers. Compounds of the present invention containing an  
asymmetrically substituted atom may be isolated in  
optically active or racemic forms. It is well known in the  
art how to prepare optically active forms, such as by  
resolution of racemic forms or by synthesis from optically  
25 active starting materials. Geometric isomers of double  
bonds such as olefins and C=N double bonds can also be  
present in the compounds described herein, and all such  
stable isomers are contemplated in the present invention.  
Cis and trans geometric isomers of the compounds of the  
30 present invention are described and may be isolated as a  
mixture of isomers or as separated isomeric forms. All  
chiral, diastereomeric, racemic forms and all geometric

isomeric forms of a structure are intended, unless the specific stereochemistry or isomeric form is specifically indicated. All processes used to prepare compounds of the present invention and intermediates made therein are  
5 considered to be part of the present invention.

Preferably, the molecular weight of compounds of the present invention is less than about 500, 550, 600, 650, 700, 750, 800, 850, or 900 grams per mole. More preferably, the molecular weight is less than about 850  
10 grams per mole. Even more preferably, the molecular weight is less than about 750 grams per mole. Still more preferably, the molecular weight is less than about 700 grams per mole.

The term "substituted," as used herein, means that any  
15 one or more hydrogens on the designated atom is replaced with a selection from the indicated group, provided that the designated atom's normal valency is not exceeded, and that the substitution results in a stable compound. When a substituent is keto (i.e., =O), then 2 hydrogens on the  
20 atom are replaced. Keto substituents are not present on aromatic moieties. When a ring system (e.g., carbocyclic or heterocyclic) is said to be substituted with a carbonyl group or a double bond, it is intended that the carbonyl group or double bond be part (i.e., within) of the ring.

25 The term "acylation" as used herein describes the functionalization of a primary or secondary amine by reacting it with an "acylator" to form a stable compound. Examples of acylators include (but are not limited to) an acid chloride, a carboxylic acid anhydride, a sulfonyl  
30 chloride, a chloroformate, an isocyanate, an isothiocyanate, etc. the product of which is an amide, a



sulfonamide, a carbamate, a urea, and a thiourea respectively.

The present invention is intended to include all isotopes of atoms occurring in the present compounds.

5 Isotopes include those atoms having the same atomic number but different mass numbers. By way of general example and without limitation, isotopes of hydrogen include tritium and deuterium. Isotopes of carbon include C-13 and C-14.

The term "independently selected from",  
10 "independently, at each occurrence" or similar language, means that the labeled R substitution group may appear more than once and that each appearance may be a different atom or molecule found in the definition of that labeled R substitution group. Thus if the labeled R<sup>a</sup> substitution  
15 group appear four times in a given permutation of Formula I, then each of those labeled R<sup>a</sup> substitution groups may be a different group falling in the definition of R<sup>a</sup>. Also, combinations of substituents and/or variables are permissible only if such combinations result in stable  
20 compounds.

When any variable (e.g., R<sup>6</sup>) occurs more than one time in any constituent or formula for a compound, its definition at each occurrence is independent of its definition at every other occurrence. Thus, for example,  
25 if a group is shown to be substituted with 0-2 R<sup>6</sup>, then said group may optionally be substituted with up to two R<sup>6</sup> groups and R<sup>6</sup> at each occurrence is selected independently from the definition of R<sup>6</sup>. Also, combinations of substituents and/or variables are permissible only if such  
30 combinations result in stable compounds.

When a bond to a substituent is shown to cross a bond connecting two atoms in a ring, then such substituent may

be bonded to any atom on the ring. When a substituent is listed without indicating the atom via which such substituent is bonded to the rest of the compound of a given formula, then such substituent may be bonded via any atom in such substituent. Combinations of substituents and/or variables are permissible only if such combinations result in stable compounds.

In cases wherein there are amines on the compounds of this invention, these can be converted to amine N-oxides by treatment with MCPBA and or hydrogen peroxides to afford other compounds of this invention. Thus, all shown amines are considered to cover both the shown amine and its N-oxide ( $N \rightarrow O$ ) derivative.

As used herein, "alkyl" or "alkylene" is intended to include both branched and straight-chain saturated aliphatic hydrocarbon groups having the specified number of carbon atoms.  $C_{1-10}$  alkyl (or alkylene), is intended to include  $C_1$ ,  $C_2$ ,  $C_3$ ,  $C_4$ ,  $C_5$ ,  $C_6$ ,  $C_7$ ,  $C_8$ ,  $C_9$ , and  $C_{10}$  alkyl groups. Examples of alkyl include, but are not limited to, methyl, ethyl, n-propyl, i-propyl, n-butyl, s-butyl, t-butyl, n-pentyl, and s-pentyl. "Haloalkyl" is intended to include both branched and straight-chain saturated aliphatic hydrocarbon groups having the specified number of carbon atoms, substituted with 1 or more halogen (for example  $-C_vF_w$  where  $v=1$  to 3 and  $w=1$  to  $(2v+1)$ ). Examples of haloalkyl include, but are not limited to, trifluoromethyl, trichloromethyl, pentafluoroethyl, and pentachloroethyl. "Alkoxy" represents an alkyl group as defined above with the indicated number of carbon atoms attached through an oxygen bridge.  $C_{1-10}$  alkoxy, is intended to include  $C_1$ ,  $C_2$ ,  $C_3$ ,  $C_4$ ,  $C_5$ ,  $C_6$ ,  $C_7$ ,  $C_8$ ,  $C_9$ , and  $C_{10}$  alkoxy groups. Examples of alkoxy include, but are not

limited to, methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, s-butoxy, t-butoxy, n-pentoxy, and s-pentoxy. "Cycloalkyl" is intended to include saturated ring groups, such as cyclopropyl, cyclobutyl, or cyclopentyl. C<sub>3-7</sub> cycloalkyl, is intended to include C<sub>3</sub>, C<sub>4</sub>, C<sub>5</sub>, C<sub>6</sub>, and C<sub>7</sub> cycloalkyl groups. "Alkenyl" or "alkenylene" is intended to include hydrocarbon chains of either a straight or branched configuration and one or more unsaturated carbon-carbon bonds which may occur in any stable point along the chain, such as ethenyl and propenyl. C<sub>2-10</sub> alkenyl (or alkenylene), is intended to include C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub>, C<sub>5</sub>, C<sub>6</sub>, C<sub>7</sub>, C<sub>8</sub>, C<sub>9</sub>, and C<sub>10</sub> alkenyl groups. "Alkynyl" or "alkynylene" is intended to include hydrocarbon chains of either a straight or branched configuration and one or more triple carbon-carbon bonds which may occur in any stable point along the chain, such as ethynyl and propynyl. C<sub>2-10</sub> alkynyl (or alkynylene), is intended to include C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub>, C<sub>5</sub>, C<sub>6</sub>, C<sub>7</sub>, C<sub>8</sub>, C<sub>9</sub>, and C<sub>10</sub> alkynyl groups.

"Halo" or "halogen" as used herein refers to fluoro, chloro, bromo, and iodo; and "counterion" is used to represent a small, negatively charged species such as chloride, bromide, hydroxide, acetate, and sulfate.

As used herein, "carbocycle" or "carbocyclic residue" is intended to mean any stable 3, 4, 5, 6, or 7-membered monocyclic or bicyclic or 7, 8, 9, 10, 11, 12, or 13-membered bicyclic or tricyclic, any of which may be saturated, partially unsaturated, or aromatic. Examples of such carbocycles include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, adamantyl, cyclooctyl, [3.3.0]bicyclooctane, [4.3.0]bicyclononane, [4.4.0]bicyclodecane,

[2.2.2]bicyclooctane, fluorenyl, phenyl, naphthyl, indanyl, adamantyl, and tetrahydronaphthyl.

As used herein, the term "heterocycle" or "heterocyclic group" is intended to mean a stable 5, 6, or 7-membered monocyclic or bicyclic or 7, 8, 9, or 10-membered bicyclic heterocyclic ring which is saturated, partially unsaturated or unsaturated (aromatic), and which consists of carbon atoms and 1, 2, 3, or 4 heteroatoms independently selected from the group consisting of N, O and S and including any bicyclic group in which any of the above-defined heterocyclic rings is fused to a benzene ring. The nitrogen and sulfur heteroatoms may optionally be oxidized. The nitrogen atom may be substituted or unsubstituted (i.e., N or NR wherein R is H or another substituent, if defined). The heterocyclic ring may be attached to its pendant group at any heteroatom or carbon atom that results in a stable structure. The heterocyclic rings described herein may be substituted on carbon or on a nitrogen atom if the resulting compound is stable. A nitrogen in the heterocycle may optionally be quaternized. It is preferred that when the total number of S and O atoms in the heterocycle exceeds 1, then these heteroatoms are not adjacent to one another. It is preferred that the total number of S and O atoms in the heterocycle is not more than 1. As used herein, the term "aromatic heterocyclic group" or "heteroaryl" is intended to mean a stable 5, 6, or 7-membered monocyclic or bicyclic or 7, 8, 9, or 10-membered bicyclic heterocyclic aromatic ring which consists of carbon atoms and 1, 2, 3, or 4 heteroatoms independently selected from the group consisting of N, O and S. It is to be noted that total number of S and O atoms in the aromatic heterocycle is not more than 1.

Examples of heterocycles include, but are not limited to, acridinyl, azocinyl, benzimidazolyl, benzofuranyl, benzothiophenyl, benzoxazolyl, benzthiazolyl, benztriazolyl, benzisoxazolyl, benzisothiazolyl, benzimidazoliny, carbazolyl, 4*H*-carbazolyl, carbolinyl, chromanyl, chromenyl, cinnolinyl, decahydroquinolinyl, 2*H*,6*H*-1,5,2-dithiazinyl, dihydrofuro[2,3-*b*]tetrahydrofuran, furanyl, furazanyl, imidazolidinyl, imidazoliny, imidazolyl, 1*H*-indazolyl, indolenyl, indolinyl, indoliziny, indolyl, 3*H*-indolyl, isobenzofuranyl, isochromanyl, isoindazolyl, isoindolinyl, isoindolyl, isoquinolinyl, isothiazolyl, isoxazolyl, methylenedioxyphenyl, morpholinyl, naphthyridinyl, octahydroisoquinolinyl, oxadiazolyl, 1,2,3-oxadiazolyl, 1,2,4-oxadiazolyl, 1,2,5-oxadiazolyl, 1,3,4-oxadiazolyl, oxazolidinyl, oxazolyl, oxazolidinyl, pyrimidinyl, phenanthridinyl, phenanthrolinyl, phenaziny, phenothiazinyl, phenoxathiinyl, phenoxazinyl, phthalazinyl, piperazinyl, piperidinyl, piperidonyl, 4-piperidonyl, piperonyl, pteridinyl, purinyl, pyranyl, pyrazinyl, pyrazolidinyl, pyrazolinyl, pyrazolyl, pyridazinyl, pyridooxazole, pyridoimidazole, pyridothiazole, pyridinyl, pyridyl, pyrrolidinyl, pyrrolinyl, 2*H*-pyrrolyl, pyrrolyl, quinazolinyl, quinolinyl, 4*H*-quinoliziny, quinoxalinyl, quinuclidinyl, tetrahydrofuranyl, tetrahydroisoquinolinyl, tetrahydroquinolinyl, tetrazolyl, 6*H*-1,2,5-thiadiazinyl, 1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,2,5-thiadiazolyl, 1,3,4-thiadiazolyl, thianthrenyl, thiazolyl, thienyl, thienothiazolyl, thienooxazolyl, thienoimidazolyl, thienyl, triazinyl, 1,2,3-triazolyl, 1,2,4-triazolyl, 1,2,5-triazolyl, 1,3,4-triazolyl, xanthenyl, 1,1-dioxido-2,3-dihydro-4*H*-1,4-benzothiazin-4-yl, 1,1-dioxido-3,4-dihydro-

2H-1-benzothiopyran-4-yl, 3,4-dihydro-2H-chromen-4-yl,  
imidazo[1,2-a]pyridinyl, imidazo[1,5-a]pyridinyl, and  
pyrazolo[1,5-a]pyridinyl. Also included are fused ring and  
spiro compounds containing, for example, the above  
5 heterocycles.

The phrase "pharmaceutically acceptable" is employed  
herein to refer to those compounds, materials,  
compositions, and/or dosage forms which are, within the  
scope of sound medical judgment, suitable for use in  
10 contact with the tissues of human beings and animals  
without excessive toxicity, irritation, allergic response,  
or other problem or complication, commensurate with a  
reasonable benefit/risk ratio.

As used herein, "pharmaceutically acceptable salts"  
15 refer to derivatives of the disclosed compounds wherein the  
parent compound is modified by making acid or base salts  
thereof. Examples of pharmaceutically acceptable salts  
include, but are not limited to, mineral or organic acid  
salts of basic residues such as amines; and alkali or  
20 organic salts of acidic residues such as carboxylic acids.  
The pharmaceutically acceptable salts include the  
conventional non-toxic salts or the quaternary ammonium  
salts of the parent compound formed, for example, from non-  
toxic inorganic or organic acids. For example, such  
25 conventional non-toxic salts include those derived from  
inorganic acids such as hydrochloric, hydrobromic,  
sulfuric, sulfamic, phosphoric, and nitric; and the salts  
prepared from organic acids such as acetic, propionic,  
succinic, glycolic, stearic, lactic, malic, tartaric,  
30 citric, ascorbic, pamoic, maleic, hydroxymaleic,  
phenylacetic, glutamic, benzoic, salicylic, sulfanilic, 2-

acetoxybenzoic, fumaric, toluenesulfonic, methanesulfonic, ethane disulfonic, oxalic, and isethionic..

The pharmaceutically acceptable salts of the present invention can be synthesized from the parent compound that  
5 contains a basic or acidic moiety by conventional chemical methods. Generally, such salts can be prepared by reacting the free acid or base forms of these compounds with a stoichiometric amount of the appropriate base or acid in water or in an organic solvent, or in a mixture of the two;  
10 generally, nonaqueous media like ether, ethyl acetate, ethanol, isopropanol, or acetonitrile are preferred. Lists of suitable salts are found in *Remington's Pharmaceutical Sciences*, 17th ed., Mack Publishing Company, Easton, PA, 1985, p. 1418, the disclosure of which is hereby  
15 incorporated by reference.

Since prodrugs are known to enhance numerous desirable qualities of pharmaceuticals (e.g., solubility, bioavailability, manufacturing, etc.) the compounds of the present invention may be delivered in prodrug form. Thus,  
20 the present invention is intended to cover prodrugs of the presently claimed compounds, methods of delivering the same and compositions containing the same. "Prodrugs" are intended to include any covalently bonded carriers which release an active parent drug of the present invention in  
25 vivo when such prodrug is administered to a mammalian subject. Prodrugs the present invention are prepared by modifying functional groups present in the compound in such a way that the modifications are cleaved, either in routine manipulation or *in vivo*, to the parent compound. Prodrugs  
30 include compounds of the present invention wherein a hydroxy, amino, or sulfhydryl group is bonded to any group that, when the prodrug of the present invention is

administered to a mammalian subject, it cleaves to form a free hydroxyl, free amino, or free sulfhydryl group, respectively. Examples of prodrugs include, but are not limited to, acetate, formate and benzoate derivatives of alcohol and amine functional groups in the compounds of the present invention.

"Stable compound" and "stable structure" are meant to indicate a compound that is sufficiently robust to survive isolation to a useful degree of purity from a reaction mixture, and formulation into an efficacious therapeutic agent.

As used herein, "treating" or "treatment" cover the treatment of a disease-state in a mammal, particularly in a human, and include: (a) preventing the disease-state from occurring in a mammal, in particular, when such mammal is predisposed to the disease-state but has not yet been diagnosed as having it; (b) inhibiting the disease-state, i.e., arresting its development; and/or (c) relieving the disease-state, i.e., causing regression of the disease state.

"Therapeutically effective amount" is intended to include an amount of a compound of the present invention or an amount of the combination of compounds claimed effective to inhibit a desired metalloprotease in a host. The combination of compounds is preferably a synergistic combination. Synergy, as described for example by Chou and Talalay, Adv. Enzyme Regul. 22:27-55 (1984), occurs when the effect (in this case, inhibition of the desired target) of the compounds when administered in combination is greater than the additive effect of the compounds when administered alone as a single agent. In general, a synergistic effect is most clearly demonstrated at



suboptimal concentrations of the compounds. Synergy can be in terms of lower cytotoxicity, increased anti-inflammatory effect, or some other beneficial effect of the combination compared with the individual components.

5

#### SYNTHESIS

The compounds of the present invention can be prepared in a number of ways well known to one skilled in the art of organic synthesis. The compounds of the present invention  
10 can be synthesized using the methods described below, together with synthetic methods known in the art of synthetic organic chemistry, or variations thereon as appreciated by those skilled in the art. Preferred methods include, but are not limited to, those described below. All  
15 references cited herein are hereby incorporated in their entirety herein by reference.

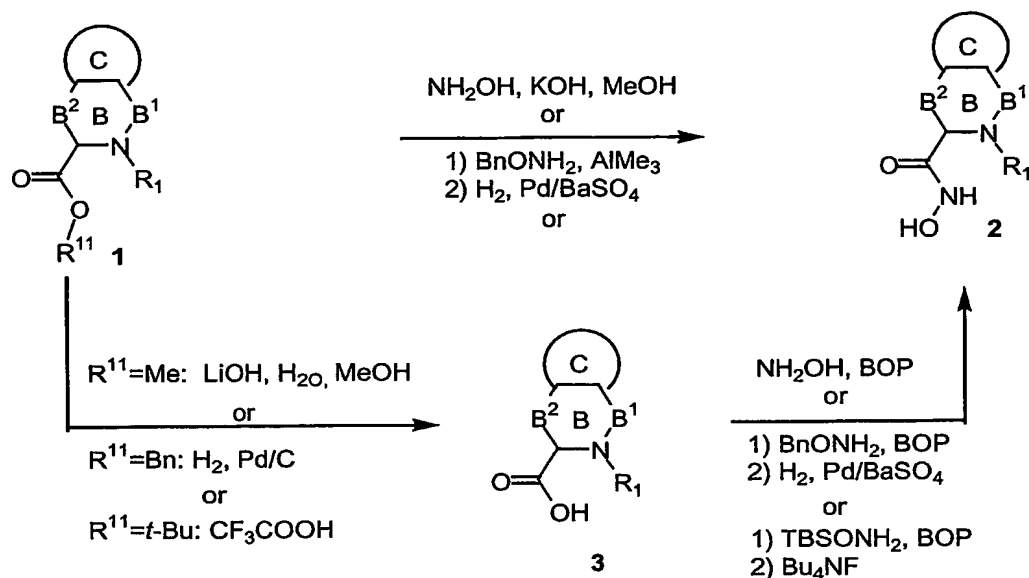
The novel compounds of this invention may be prepared using the reactions and techniques described in this section. The reactions are performed in solvents  
20 appropriate to the reagents and materials employed and are suitable for the transformations being effected. Also, in the description of the synthetic methods described below, it is to be understood that all proposed reaction conditions, including choice of solvent, reaction  
25 atmosphere, reaction temperature, duration of the experiment and work up procedures, are chosen to be the conditions standard for that reaction, which should be readily recognized by one skilled in the art. It is understood by one skilled in the art of organic synthesis  
30 that the functionality present on various portions of the molecule must be compatible with the reagents and reactions proposed. Such restrictions to the substituents that are

compatible with the reaction conditions will be readily apparent to one skilled in the art and alternate methods must then be used.

A variety of compounds of formula (I) wherein A is  
5 hydroxamic acid group are prepared from the corresponding esters or carboxylic acids using several routes known in the literature (Scheme 1). The methyl ester of **1** ( $R^{11}=\text{Me}$ ) is directly converted to hydroxamic acid **2** by treatment with hydroxylamine under basic conditions such as KOH or  
10 NaOMe in solvents such as methanol. The methyl ester of **1** ( $R^{11}=\text{Me}$ ) can also be converted to O-benzyl protected hydroxamic acid with O-benzylhydroxylamine under similar conditions or using Weinreb's trimethylaluminum conditions (Levin, J. I.; Turos, E.; Weinreb, S. M. *Syn. Commun.* **1982**,  
15 *12*, 989) or Roskamp's bis[bis(trimethylsilyl)amido]tin reagent (Wang, W.-B.; Roskamp, E. J. *J. Org. Chem.* **1992**, *57*, 6101). The benzyl ether is removed by methods well known in the literature such as hydrogenation using palladium on barium sulfate in hydrogen, to give compound  
20 **2**. Alternatively, **2** can be prepared through the carboxylic intermediate **3**. Carboxylic acid **3** is converted to **2** via coupling with hydroxylamine, or its protected equivalents (O-benzylhydroxylamine or O-t-butyl dimethylsiloxyamine) followed by deprotection.

25

Scheme 1

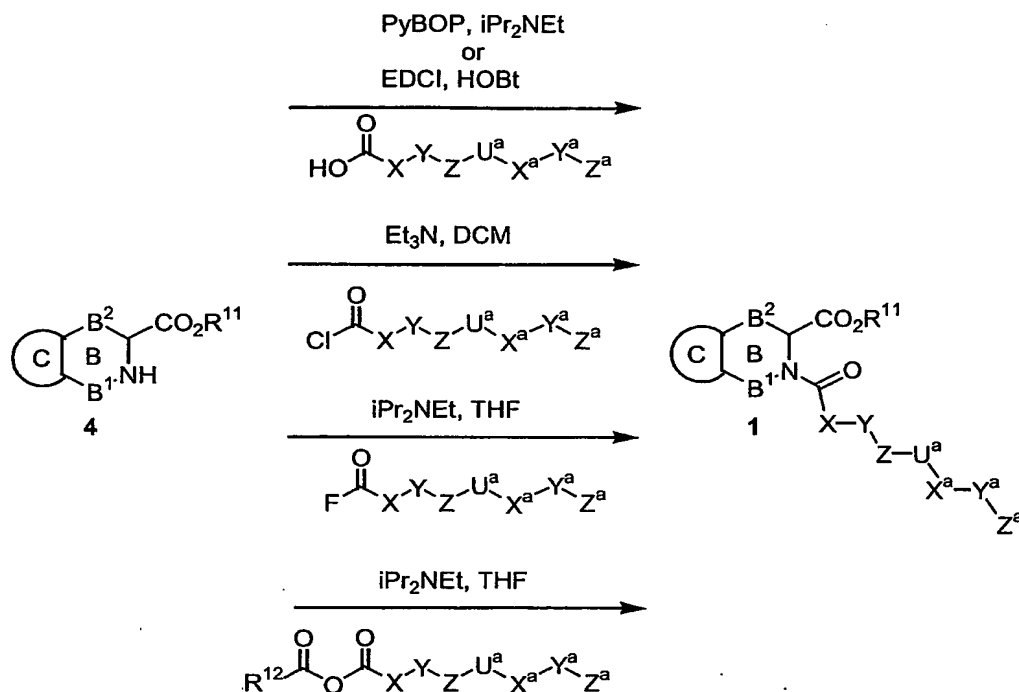


Compound 1 can be prepared by coupling the

5 corresponding amine with the carboxylic acid derivative as shown in Scheme 2 to form amides. Coupling with PyBOP and base gives the corresponding amide with unhindered carboxylic acids but more sterically hindered acids require more reactive groups such as the corresponding acid

10 chlorides, acid fluorides, or anhydrides.

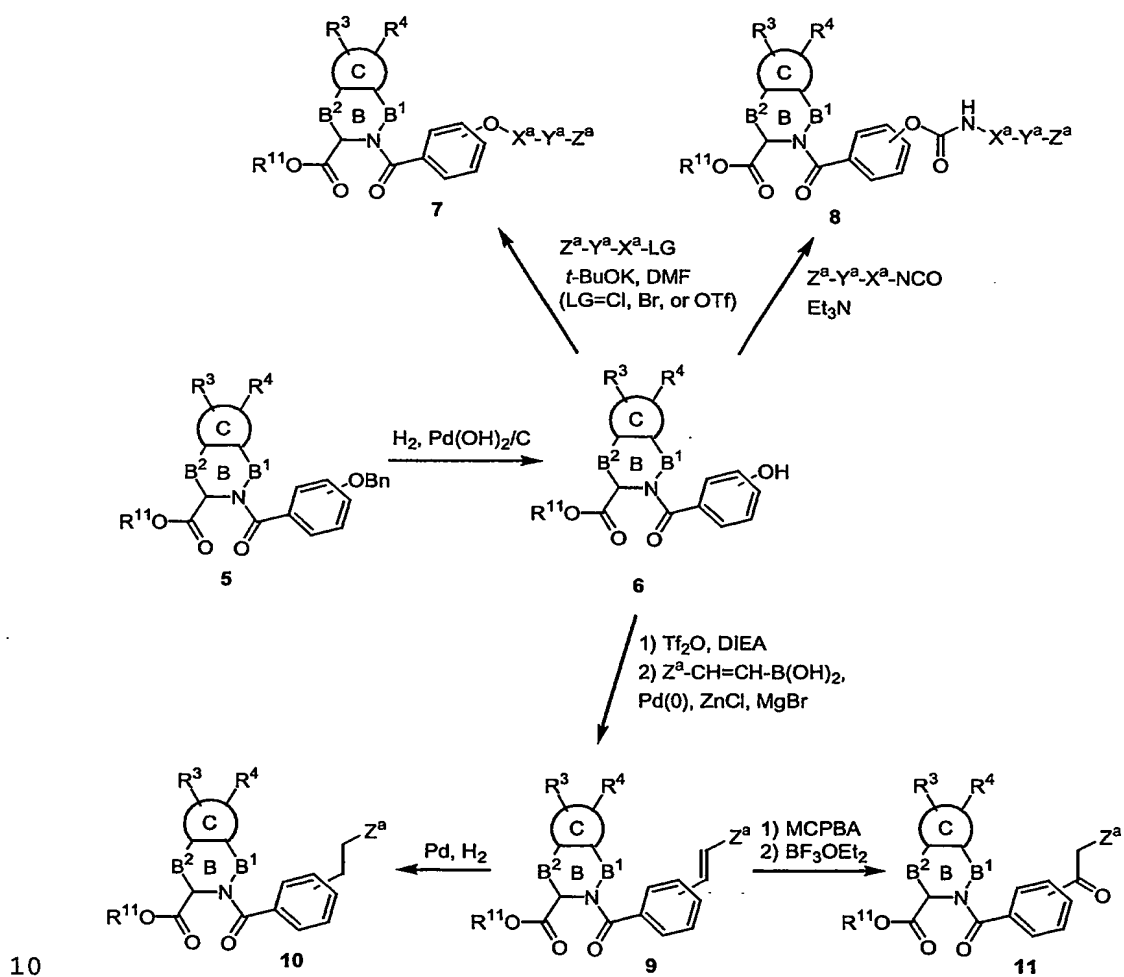
Scheme 2



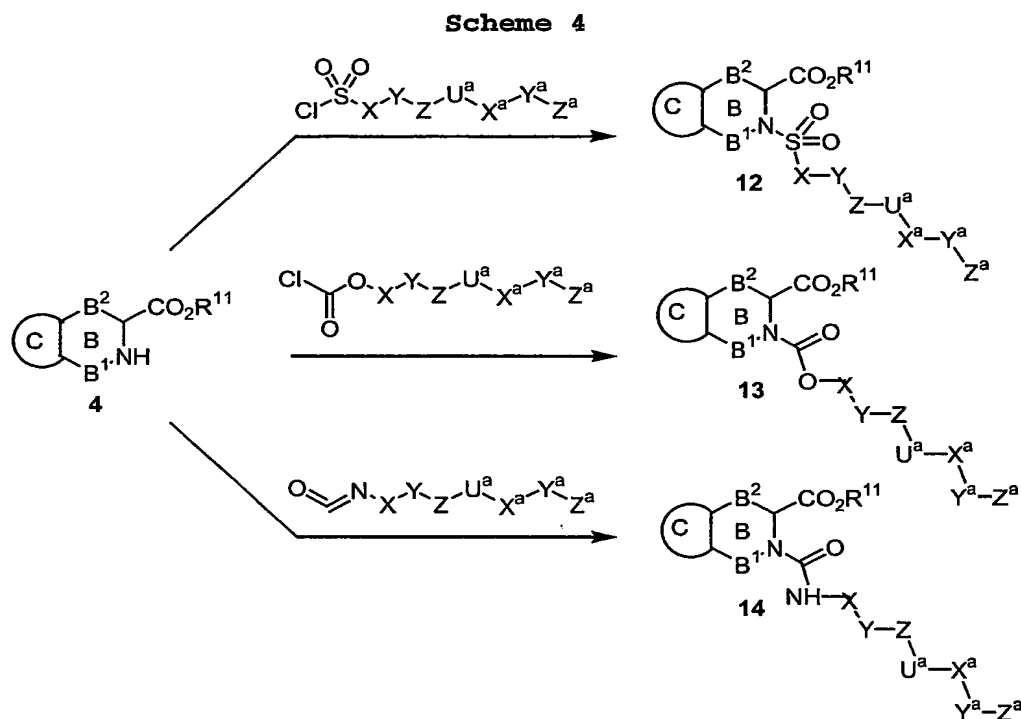
- 5 A variety of compounds of formula I wherein X-Y-Z-U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup>-Z<sup>a</sup> is a functionalized phenyl group can be prepared by methods described in Scheme 3. Intermediate 5, available from schemes described previously, is converted to phenol 6 by hydrogenolysis. Phenol 6 is used as a common
- 10 intermediate for structure diversification. Reaction of 6 with an electrophile R<sup>C</sup>-X provides the alkylated product 7, which alternatively can be synthesized by reacting 6 with R<sup>C</sup>-OH under Mitsunobu conditions to produce 7. Compound 6 may also be reacted with acylators such as isocyanates to
- 15 form carbamates, as depicted in product structure 8. Treatment of compound 6 with triflic anhydride yields an intermediate aryl triflate which can participate in the Suzuki reaction with vinyl boronic acids in the presence of

- Pd(0) catalysts to form intermediate **9**. The olefin in intermediate **9** can be reduced directly to compound **10** or alternatively, oxidized with MCPBA to an intermediate epoxide and rearranged with  $\text{BF}_3\text{OEt}_2$  to form ketone **11**.
- 5 Esters **7**, **8**, **10**, and **11** are converted to the hydroxamic acids following the sequences outlined in Scheme 1.

Scheme 3



An alternative to the amidation of amine **4** as described previously in Scheme 2 is the acylation of **4** with a variety of other functional groups, some of which are depicted in Scheme 4. Esters **12-14** are then converted to their corresponding hydroxamates using the methods described in Scheme 1.

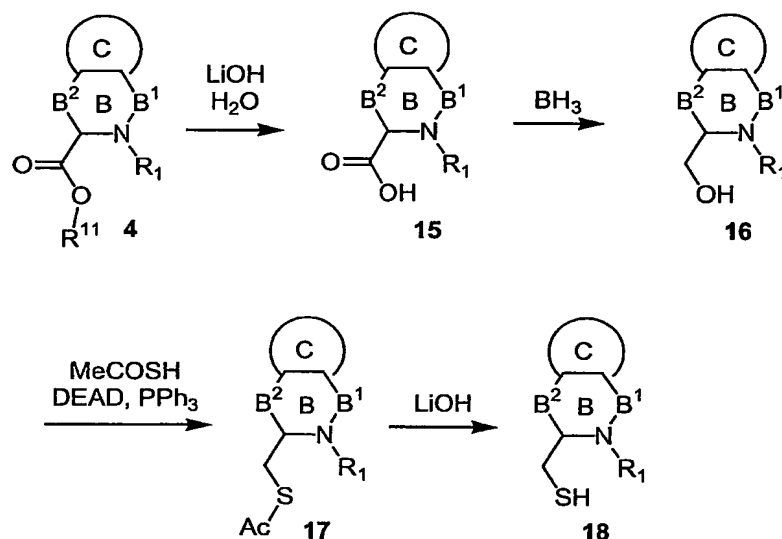


10

Although the hydroxamic acid of structure **2** is an important component of MMP inhibition, the heterocycle can be synthesized with non-hydroxamate substitution such as a mercaptomethyl functional group. As shown in Scheme 5, the final compound **18** may be derived from an ester **4** via hydrolysis of the ester and selective borane reduction of the carboxylic acid to give compound **16**. The primary hydroxyl can be transposed to the primary thiol in a number

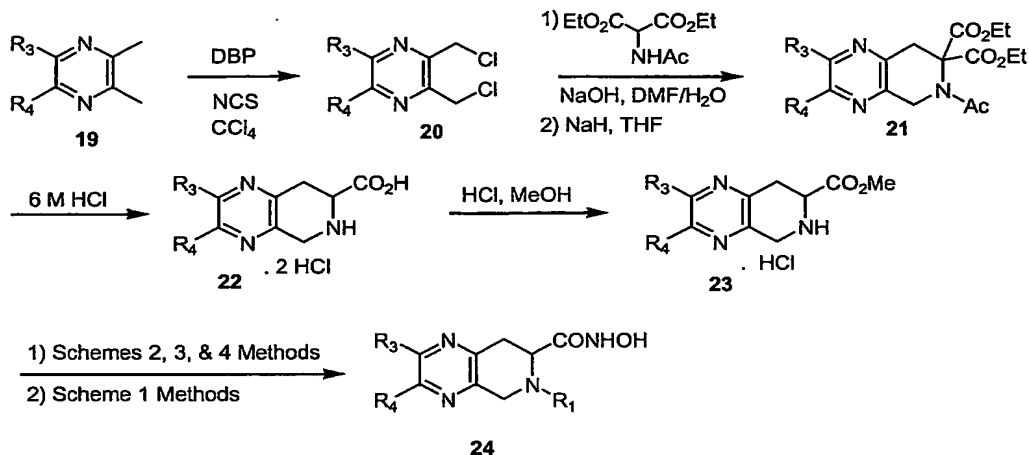
of ways, shown here is Mitsunobu addition of thioacetic acid followed by hydrolysis to give compound **18**.

Scheme 5



A series of compounds containing a quinazoline core structure were assembled using synthetic Scheme 6. 2,3-dimethylquinazoline **19** is treated with N-chlorosuccinimide and dibenzoylperoxide to chlorinate the benzylic positions. Treatment of **20** with diethyl(N-acetylamino)malonate under basic conditions followed by sodium hydride annulates the ring to form **21**. Deacetylation and hydrolytic decarboxylation are accomplished using  $\text{HCl(aq)}$  and the carboxylate is re-esterified using acidic  $\text{MeOH}$  to give **23**. Hydroxamate **24** is formed by functionalizing the amine of compound **23** with acylators using the methods outlined in Schemes 2-4 followed by conversion of the ester to the hydroxamic acid **24** as discussed above.

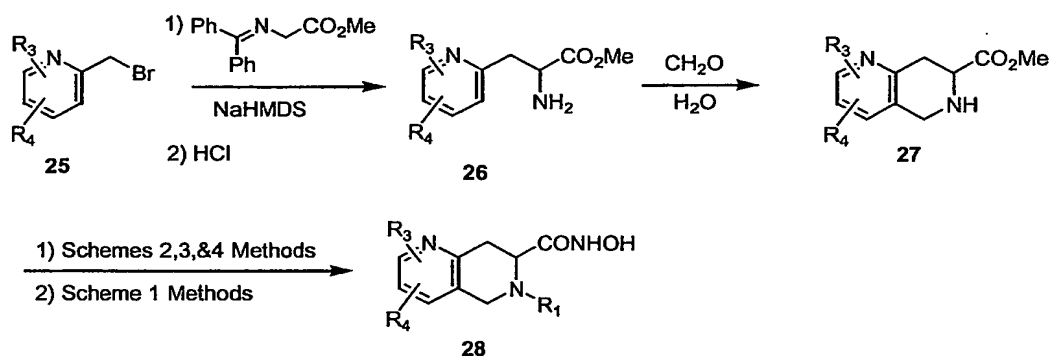
Scheme 6



5 Other substituted quinoline core structures can be  
 made via substituted heteroaryl and heterocyclic  $\alpha$ -amino  
 acids such as **26** in Scheme 7. Many methods exist for  
 making  $\alpha$ -amino acids (see for instance: Easton, C.J.; *Chem.*  
*Rev.*, **1997**, 97,53-82 and references therein) and shown here  
 10 is the method of O'Donnell (see *J. Org. Chem.* **1982**, 47,  
 2663-2666). Alkylation of glycine benzophenone imine with  
 a benzylic electrophile yields compound **26** after  
 deprotection of the imine. Treatment of the amino ester  
 with formaldehyde results in Pictet-Spengler cyclization to  
 15 yield the heterocycle **27** that can be acylated using the  
 methods found in Schemes 2-4 and converted to hydroxamate  
**28** using the methods in Scheme 1.



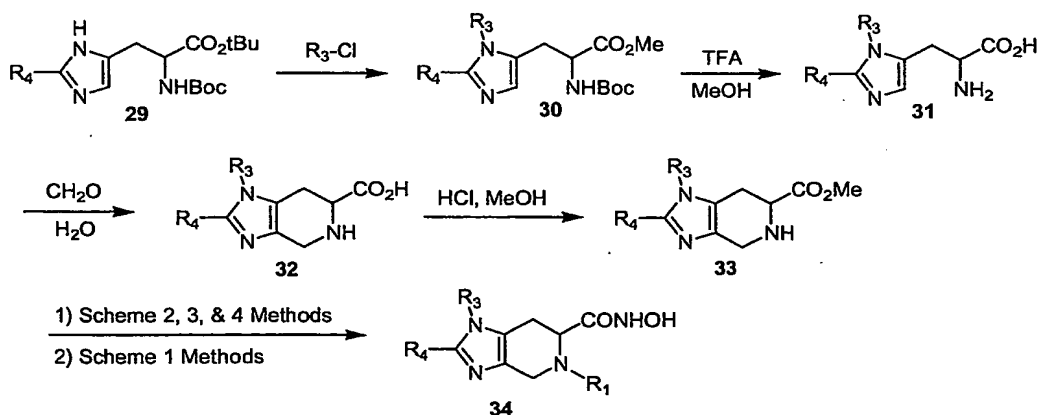
## Scheme 7



In Scheme 8 substituted imidazoles were prepared using the procedure of Neuberger et al (*Biochem. J.* **1944**, *38*, 309, 312). Protected histidine derivateives such as **29** are functionalized with a variety of R3 groups and deprotected to give compound **31**. Treatment of the amine with formaldehyde results in Pictet-Spengler type cyclization to yield **32** which is esterified under acidic conditions to give **33**. Acylation of the amine (Schemes 2,3,4) followed by conversion to the hydroxamate (Scheme 1) give the final hydroxamic acid **34**.

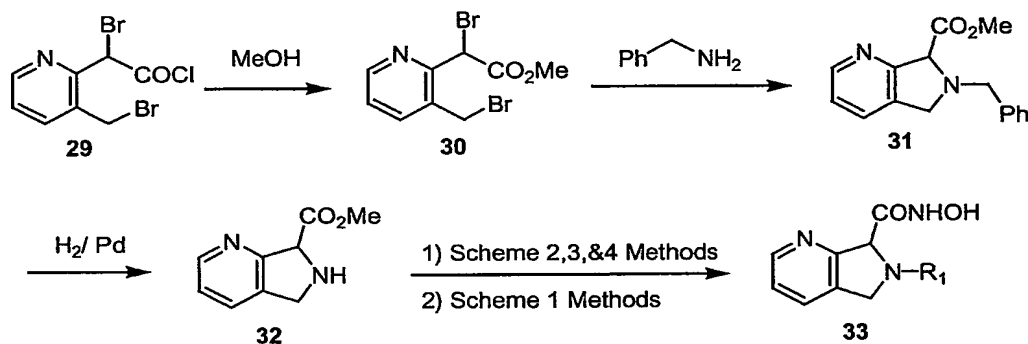
15

## Scheme 8



The synthesis of core structure **33** is illustrated in Scheme 9 using the method of Klutchko et al (*J. Med. Chem.* **1986**, *29*, 1953). The bis-alkyl bromide **29** can be synthesized using methods known to one skilled in the art of organic synthesis. Esterification of the acid chloride with MeOH gives the methyl ester **30** which can participate in a double SN2 reaction to yield the protected heterocycle **31**. Hydrogenolytic removal of the benzyl group provides the basic core structure **32** which is functionalized by acylation and subsequent hydroxamate formation using the synthetic methods in Schemes 2-4 and Scheme 1 respectively.

Scheme 9



When required, separation of the racemic material can be achieved by HPLC using a chiral column or by a resolution using a resolving agent such as camphonic chloride as in Steven D. Young, et al, *Antimicrobial Agents and Chemotherapy*, **1995**, 2602-2605. A chiral compound of Formula I may also be directly synthesized using a chiral catalyst or a chiral ligand, e.g., Andrew S. Thompson, et al, *Tetr. Lett.* **1995**, *36*, 8937-8940. Other features of the invention will become apparent in the course of the following descriptions of exemplary embodiments that are given for illustration of the invention and are not intended to be limiting thereof.

## EXAMPLES

Abbreviations used in the Examples are defined as follows: "1 x" for once, "2 x" for twice, "3 x" for thrice,  
5 "°C" for degrees Celsius, "eq" for equivalent or equivalents, "g" for gram or grams, "mg" for milligram or milligrams, "mL" for milliliter or milliliters, "<sup>1</sup>H" for proton, "h" for hour or hours, "M" for molar, "min" for minute or minutes, "MHz" for megahertz, "MS" for mass  
10 spectroscopy, "NMR" for nuclear magnetic resonance spectroscopy, "HPLC" for high performance liquid chromatography, "rt" for room temperature, "tlc" for thin layer chromatography, "v/v" for volume to volume ratio.  
"α", "β", "D", "L", "R" and "S" are stereochemical  
15 designations familiar to those skilled in the art.

## Example 1

**N-hydroxy-6-({4-[(2-methyl-4-  
quinolinyl)methoxy]phenyl}acetyl)-5,6,7,8-  
20 tetrahydropyrido[3,4-b]pyrazine-7-carboxamide**

*(1a) 2,3-bis(chloromethyl)pyrazine*

To a solution of 2,3-dimethylpyrazine (6.27g, 57.4 mmol) in 100 mL of carbon tetrachloride was added N-  
25 chlorosuccinimide (16.7 g) followed by benzoyl peroxide (278 mg, 2 mol%) and the solution was heated to reflux for 16 h. The reaction was cooled, more benzoyl peroxide (278 mg, 2 mol%) was added and the reaction was refluxed for 5 h. The reaction was monitored by TLC until the  
30 disappearance of starting pyrazine. The reaction flask was cooled in an ice bath, the solution filtered, and the eluent was concentrated and chromatographed on SiO<sub>2</sub> using

15% EtOAc in hexane. Obtained 1.14 g of the product (11% yield). MS found:  $(M+H)^+ = 178$ .

5 *(1b) Diethyl 2-(acetylamino)-2-([3-(chloromethyl)-2-pyrazinyl]methyl)malonate*

To a solution of 2,3-bis(chloromethyl)pyrazine (2.06 g, 11.64 mmol) in 60 mL DCM was added diethyl(N-acetylamino)malonate (2.66 g, 11.7 mmol) anhydrous potassium carbonate (4.83, 34.9 mmol) and 18-C-6 (154 mg, 5 mol%) and  
10 the reaction was stirred for 48 h. The reaction was filtered through a sintered glass funnel, concentrated, and flash chromatographed on SiO<sub>2</sub> using a 50% to 75% EtOAc in hexane gradient. Obtained 3.06 g or 56% yield of the product. MS found:  $(M+H)^+ = 359$ .

15

*(1c) Diethyl 6-acetyl-5,8-dihydropyrido[3,4-b]pyrazine-7,7(6H)-dicarboxylate*

To a solution of 1b (1.1 g, 2.36 mmol) in 40 mL THF was added NaH (170 mg, 4.25 mmol, 60% oil dispersion) under N<sub>2</sub>  
20 and the solution was stirred for 30 min. The reaction was carefully quenched with water and extracted from sat NaHCO<sub>3</sub> 3 x with EtOAc. The organic layers were dried with MgSO<sub>4</sub>, filtered, concentrated, and chromatographed on SiO<sub>2</sub> using 75% EtOAc in hexane to give 640 mg of 1c as an HCl salt  
25 (85% yield). MS found:  $(M+H)^+ = 322$ .

*(1d) Methyl 6-([4-[(2-methyl-4-quinolinyl)methoxy]phenyl]acetyl)-5,6,7,8-tetrahydropyrido[3,4-b]pyrazine-7-carboxylate*  
30 Compound 1c (0.557 mmol) was dissolved in 6 M HCl (3 mL) and refluxed for 1.5 h. The reaction was cooled,

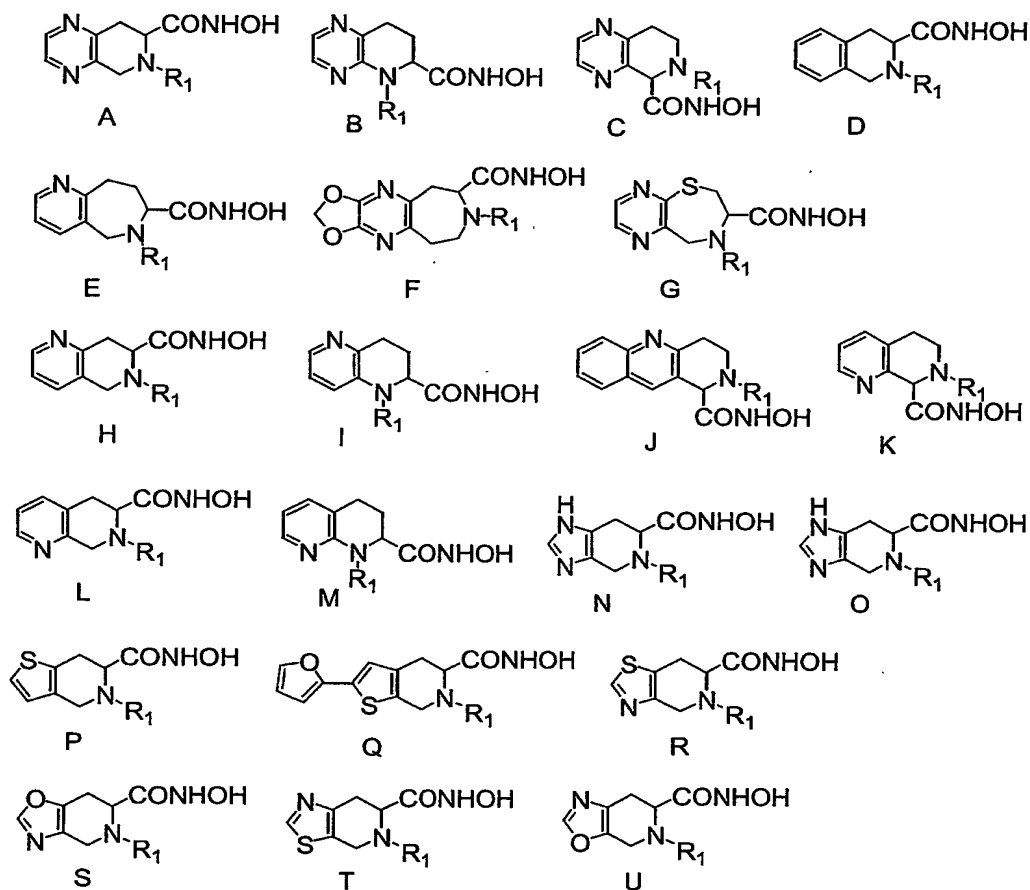
concentrated in vacuo, taken up in sat HCl in MeOH (10 mL), and refluxed overnight. The reaction was concentrated in vacuo to give the crude amino ester HCl salt. The crude material was taken up in 10 mL MeOH and HCl (g) was bubbled  
5 through the solution for 30 min. After stirring o/n the reaction was concentrated and dried under vacuum. To this crude amino ester was dissolved in 2 mL DMF followed by the addition of {4-[(2-methyl-4-quinolinyl)methoxy]phenyl}acetic acid (205 mg, 0.67 mmol),  
10 diisopropyl-ethylamine (486  $\mu$ L, 2.79 mmol), and lastly PyBOP (377 mg, 0.72 mmol). After stirring o/n, the reaction was partitioned between EtOAc and sat NaHCO<sub>3</sub> and separated. The organic phase was dried over MgSO<sub>4</sub>, filtered, concentrated under vacuum, and passed thorough a  
15 SiO<sub>2</sub> plug using 10% MeOH in DCM. The residue was purified by HPLC to give 68 mg of 1d as a bis-TFA salt (17% yield for 3 steps). MS found: (M+H)<sup>+</sup> = 483.

(Example 1) *N*-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}acetyl)-5,6,7,8-tetrahydropyrido[3,4-*b*]pyrazine-7-carboxamide

To 1d bis-TFA salt (62 mg, 0.096 mmol) was added an anhydrous solution of hydroxylamine in MeOH (1.5 mL, 1.64 M). After 30 min, the reaction was concentrated and  
25 purified by HPLC to give 25 mg of the product 1e (37 % yield) as a bis-TFA salt after lyophilization. MS found: (M+H)<sup>+</sup> = 484.

Table 1 contains representative examples of the present invention. Each entry in the table is intended to be paired with each structural formula at the start of the table. For example, example 1 in Table 1 is intended to be

5 paired with each of the following formulae A-U.

**Table 1**

Ex	R <sub>1</sub>
1	{4-[(2,6-dimethylphenyl)methoxy]phenyl}acetyl
2	{4-[(3,5-dimethylphenyl)methoxy]phenyl}acetyl
3	{4-[(3,5-dimethylphenyl)ethyl]phenyl}acetyl
4	{4-[1-(3,5-dimethoxyphenyl)ethoxy]phenyl}acetyl

5	{4-[(3,5-dichlorophenyl)methoxy]phenyl}acetyl
6	{4-[(2,6-dichlorophenyl)methoxy]phenyl}acetyl
7	{4-[(3,5-dibromophenyl)methoxy]phenyl}acetyl
8	{4-(phenoxymethyl)phenyl}acetyl
9	{4-benzyloxyphenyl}acetyl
10	{4-[(3-aminocarbonyl-5-methylphenyl)methoxy]phenyl}acetyl
11	{4-[(1,1'-biphenyl)-2-yl]methoxy]phenyl}acetyl
12	{4-[(1,1'-biphenyl)-3-yl]methoxy]phenyl}acetyl
13	{4-[(5-methyl-3-(methylsulfonyl)phenyl)methoxy]phenyl}acetyl
14	{4-[(2-methyl-1-naphthalenyl)methoxy]phenyl}acetyl
15	{4-[(4-methyl-2-naphthalenyl)methoxy]phenyl}acetyl
16	{4-[(4-quinolinyl)methoxy]phenyl}acetyl
17	{4-[1-(4-quinolinyl)ethoxy]phenyl}acetyl
18	{4-[(2-pyridinyl)methoxy]phenyl}acetyl
19	{4-[(4-pyridinyl)methoxy]phenyl}acetyl
20	{4-[(2,6-dimethyl-4-pyridinyl)methoxy]phenyl}acetyl
21	{4-[2-(4-quinolinyl)ethyl]phenyl}acetyl
22	{4-[1-(2,6-dimethyl-4-pyridinyl)ethoxy]phenyl}acetyl
23	{4-[(3,5-dimethyl-4-pyridinyl)methoxy]phenyl}acetyl
24	{4-[(2,6-diethyl-4-pyridinyl)methoxy]phenyl}acetyl
25	{4-[(2,6-dichloro-4-pyridinyl)methoxy]phenyl}acetyl
26	{4-[(2,6-dimethoxy-4-pyridinyl)methoxy]phenyl}acetyl
27	{4-[(2-chloro-6-methyl-4-pyridinyl)methoxy]phenyl}acetyl
28	{4-[(2-chloro-6-methoxy-4-pyridinyl)methoxy]phenyl}acetyl
29	{4-[(2-methoxy-6-methyl-4-pyridinyl)methoxy]phenyl}acetyl
30	{4-[2-(1,2,3-benzotriazol-1-yl)ethyl]phenyl}acetyl
31	{4-[(2-benzimidazolyl)methoxy]phenyl}acetyl
32	{4-[(1,4-dimethyl-5-imidazolyl)methoxy]phenyl}acetyl
33	{4-[(3,5-dimethyl-4-isoxazolyl)methoxy]phenyl}acetyl
34	{4-[(4,5-dimethyl-2-oxazolyl)methoxy]phenyl}acetyl
35	{4-[(2,5-dimethyl-4-thiazolyl)methoxy]phenyl}acetyl
36	{4-[(3,5-dimethyl-1-pyrazolyl)ethyl]phenyl}acetyl
37	{4-[(1,3-benzodioxo-4-yl)methoxy]phenyl}acetyl
38	{4-[(1,3,5-trimethyl-4-pyrazolyl)methoxy]phenyl}acetyl
39	{4-[(2,6-dimethyl-4-pyrimidinyl)methoxy]phenyl}acetyl
40	{4-[(4,5-dimethyl-2-furanyl)methoxy]phenyl}acetyl
41	{4-[(4,5-dimethyl-2-thiazolyl)methoxy]phenyl}acetyl

42	{4-[2-(2-oxazolyl)ethyl]phenyl}acetyl
43	{4-[2-methyl-4-quinoliny]ethoxy}phenyl}acetyl
44	{4-[(2-methyl-4-quinoliny)ethyl]phenyl}acetyl
45	{4-[(2-methyl-1-oxo-4-quinoliny)methoxy]phenyl}acetyl
46	{4-[(2-methyl-3-pyridiny)methoxy]phenyl}acetyl
47	{4-[(2,5-dimethylbenzyl)oxy]phenyl}acetyl
48	{4-[(2-methyl-4-quinoliny)methyl]amino}phenyl}acetyl
49	{6-[(2-methyl-4-quinoliny)methoxy]-1-naphthyl}acetyl
50	6-[(2-methyl-4-quinoliny)methoxy]-1,2,3,4-tetrahydro-1-isoquinolinecarbonyl
51	6-[(2-methyl-4-quinoliny)methyl]-1,2,3,4-tetrahydro-1-isoquinolinecarbonyl
52	{4-[(2-methyl-4-quinoliny)methoxy]phenyl}acetyl
53	{4-[2-(1H-benzimidazol-1-yl)ethyl]phenyl}acetyl
54	{4-[2-(2-methyl-1H-benzimidazol-1-yl)ethyl]phenyl}acetyl
55	{4-[2-(2-isopropyl-1H-benzimidazol-1-yl)ethyl]phenyl}acetyl
56	{4-(1H-benzimidazol-2-ylmethoxy)phenyl}acetyl
57	{4-[(1-methyl-1H-benzimidazol-2-yl)methoxy]phenyl}acetyl
58	{4-[(1-isopropyl-1H-benzimidazol-2-yl)methoxy]phenyl}acetyl
59	{4-[(1H-indol-3-yl)ethyl]phenyl}acetyl
60	{4-[(5-phenyl-1H-imidazol-1-yl)ethyl]phenyl}acetyl
61	{4-[(1,1-dioxido-2,3-dihydro-4H-1,4-benzothiazin-4-yl)ethyl]phenyl}acetyl
62	{4-[2,2-dimethyl-1,1-dioxido-2,3-dihydro-4H-1,4-benzothiazin-4-yl)ethyl]phenyl}acetyl
63	4-[(2,6-dimethylphenyl)methoxy]benzenesulfonyl
64	4-[(3,5-dimethylphenyl)methoxy]benzenesulfonyl
65	4-[(3,5-dimethylphenyl)ethyl]benzenesulfonyl
66	4-[1-(3,5-dimethoxyphenyl)ethoxy]benzenesulfonyl
67	4-[(3,5-dichlorophenyl)methoxy]benzenesulfonyl
68	4-[(2,6-dichlorophenyl)methoxy]benzenesulfonyl
69	4-[(3,5-dibromophenyl)methoxy]benzenesulfonyl
70	4-(phenoxymethyl)benzenesulfonyl
71	4-benzyloxybenzenesulfonyl
72	4-[(3-aminocarbonyl-5-methylphenyl)methoxy]benzenesulfonyl
73	4-[(1,1'-biphenyl)-2-yl]methoxy}benzenesulfonyl
74	4-[[[(1,1'-biphenyl)-3-yl]methoxy}benzenesulfonyl



75	4-{ [5-methyl-3-(methylsulfonyl)phenyl] methoxy}benzenesulfonyl
76	4-[(2-methyl-1-naphthalenyl)methoxy]benzenesulfonyl
77	4-[(4-methyl-2-naphthalenyl)methoxy]benzenesulfonyl
78	4-[(4-quinolinyl)methoxy]benzenesulfonyl
79	4-[1-(4-quinolinyl)ethoxy]benzenesulfonyl
80	4-[(2-pyridinyl)methoxy]benzenesulfonyl
81	4-[(4-pyridinyl)methoxy]benzenesulfonyl
82	4-[(2,6-dimethyl-4-pyridinyl)methoxy]benzenesulfonyl
83	4-[2-(4-quinolinyl)ethyl]benzenesulfonyl
84	4-[[1-(2,6-dimethyl-4-pyridinyl)ethoxy]benzenesulfonyl
85	4-[(3,5-dimethyl-4-pyridinyl)methoxy]benzenesulfonyl
86	4-[(2,6-diethyl-4-pyridinyl)methoxy]benzenesulfonyl
87	4-[(2,6-dichloro-4-pyridinyl)methoxy]benzenesulfonyl
88	4-[(2,6-dimethoxy-4-pyridinyl)methoxy]benzenesulfonyl
89	4-[(2-chloro-6-methyl-4-pyridinyl)methoxy]benzenesulfonyl
90	4-[(2-chloro-6-methoxy-4-pyridinyl)methoxy] benzenesulfonyl
91	4-[(2-methoxy-6-methyl-4-pyridinyl)methoxy] benzenesulfonyl
92	4-[2-(1,2,3-benzotriazol-1-yl)ethyl]benzenesulfonyl
93	4-[(2-benzimidazolyl)methoxy]benzenesulfonyl
94	4-[(1,4-dimethyl-5-imidazolyl)methoxy]benzenesulfonyl
95	4-[(3,5-dimethyl-4-isoxazolyl)methoxy]benzenesulfonyl
96	4-[(4,5-dimethyl-2-oxazolyl)methoxy]benzenesulfonyl
97	4-[(2,5-dimethyl-4-thiazolyl)methoxy]benzenesulfonyl
98	4-[(3,5-dimethyl-1-pyrazolyl)ethyl]benzenesulfonyl
99	4-[(1,3-benzodioxo-4-yl)methoxy]benzenesulfonyl
100	4-[(1,3,5-trimethyl-4-pyrazolyl)methoxy]benzenesulfonyl
101	4-[(2,6-dimethyl-4-pyrimidinyl)methoxy]benzenesulfonyl
102	4-[(4,5-dimethyl-2-furanyl)methoxy]benzenesulfonyl
103	4-[(4,5-dimethyl-2-thiazolyl)methoxy]benzenesulfonyl
104	4-[2-(2-oxazolyl)ethyl]benzenesulfonyl
105	4-[2-methyl-4-quinolinyl]ethoxy]benzenesulfonyl
106	4-[(2-methyl-4-quinolinyl)ethyl]benzenesulfonyl
107	4-[(2-methyl-1-oxo-4-quinolinyl)methoxy]benzenesulfonyl
108	4-[(2-methyl-3-pyridinyl)methoxy] benzenesulfonyl
109	4-[(2,5-dimethylbenzyl)oxy] benzenesulfonyl
109	4-[(2-methyl-4-quinolinyl)methyl]amino) benzenesulfonyl

110	6-[(2-methyl-4-quinolinyl)methoxy]-1-naphthenesulfonyl
111	6-[(2-methyl-4-quinolinyl)methoxy]-1,2,3,4-tetrahydro-1-isoquinolinosulfonyl
112	6-[(2-methyl-4-quinolinyl)methyl]-1,2,3,4-tetrahydro-1-isoquinolinosulfonyl
113	4-[2-(1H-benzimidazol-1-yl)ethyl]benzenesulfonyl
114	4-[2-(2-methyl-1H-benzimidazol-1-yl)ethyl]benzenesulfonyl
115	4-[2-(2-isopropyl-1H-benzimidazol-1-yl)ethyl]benzenesulfonyl
116	4-(1H-benzimidazol-2-ylmethoxy)benzenesulfonyl
117	4-[(1-methyl-1H-benzimidazol-2-yl)methoxy]benzenesulfonyl
118	4-[(1-isopropyl-1H-benzimidazol-2-yl)methoxy]benzenesulfonyl
119	4-[(1H-indol-3-yl)ethyl]benzenesulfonyl
120	4-[(5-phenyl-1H-imidazol-1-yl)ethyl]benzenesulfonyl
121	4-[(1,1-dioxido-2,3-dihydro-4H-1,4-benzothiazin-4-yl)ethyl]benzenesulfonyl
122	4-[2,2-dimethyl-1,1-dioxido-2,3-dihydro-4H-1,4-benzothiazin-4-yl)ethyl]benzenesulfonyl
123	4-[(2-methyl-4-quinolinyl)methoxy]benzenesulfonyl

#### UTILITY

The compounds of formula I are expected to possess

5 matrix metalloprotease and/or aggrecanase and/or TNF- $\alpha$  inhibitory activity. The MMP inhibitory activity of the compounds of the present invention is demonstrated using assays of MMP activity, for example, using the assay described below for assaying inhibitors of MMP activity.

10 The compounds of the present invention are expected to be bioavailable in vivo as demonstrated, for example, using the ex vivo assay described below. The compounds of formula I are expected to have the ability to suppress/inhibit cartilage degradation in vivo, for

15 example, as demonstrated using the animal model of acute cartilage degradation described below.

The compounds provided by this invention should also be useful as standards and reagents in determining the ability of a potential pharmaceutical to inhibit MPs. These would be provided in commercial kits comprising a  
5 compound of this invention.

Metalloproteinases have also been implicated in the degradation of basement membranes to allow infiltration of cancer cells into the circulation and subsequent penetration into other tissues leading to tumor metastasis  
10 (Stetler-Stevenson, Cancer and Metastasis Reviews, 9, 289-303, 1990). The compounds of the present invention should be useful for the prevention and treatment of invasive tumors by inhibition of this aspect of metastasis.

The compounds of the present invention should also  
15 have utility for the prevention and treatment of osteopenia associated with matrix metalloprotease-mediated breakdown of cartilage and bone that occurs in osteoporosis patients.

Compounds that inhibit the production or action of TACE and/or Aggrecanase and/or MMP's are potentially useful  
20 for the treatment or prophylaxis of various inflammatory, infectious, immunological or malignant diseases or conditions. Thus, the present invention relates to a method of treating various inflammatory, infectious, immunological or malignant diseases. These include acute  
25 infection, acute phase response, age related macular degeneration, alcoholic liver disease, allergy, allergic asthma, anorexia, aneurism, aortic aneurism, asthma, atherosclerosis, atopic dermatitis, autoimmune disease, autoimmune hepatitis, Bechet's disease, cachexia (including  
30 cachexia resulting from cancer or HIV), calcium pyrophosphate dihydrate deposition disease, cardiovascular effects, chronic fatigue syndrome, chronic obstruction

pulmonary disease, coagulation, congestive heart failure, corneal ulceration, Crohn's disease, enteropathic arthropathy (including inflammatory bowel disease), Felty's syndrome, fever, fibromyalgia syndrome, fibrotic disease, 5 gingivitis, glucocorticoid withdrawal syndrome, gout, graft versus host disease, hemorrhage, HIV infection, hyperoxic alveolar injury, infectious arthritis, inflammation, intermittent hydrarthrosis, Lyme disease, meningitis, multiple sclerosis, myasthenia gravis, mycobacterial 10 infection, neovascular glaucoma, osteoarthritis, pelvic inflammatory disease, periodontitis, polymyositis/dermatomyositis, post-ischaemic reperfusion injury, post-radiation asthenia, psoriasis, psoriatic arthritis, pulmonary emphysema, pyoderma gangrenosum, 15 relapsing polychondritis, Reiter's syndrome, rheumatic fever, rheumatoid arthritis (including juvenile rheumatoid arthritis and adult rheumatoid arthritis), sarcoidosis, scleroderma, sepsis syndrome, Still's disease, shock, Sjogren's syndrome, skin inflammatory diseases, solid tumor 20 growth and tumor invasion by secondary metastases, spondylitis, stroke, systemic lupus erythematosus, ulcerative colitis, uveitis, vasculitis, and Wegener's granulomatosis.

Some compounds of the present invention have been 25 shown to inhibit TNF production in lipopolysaccharide stimulated mice, for example, using the assay for TNF induction in mice and in human whole blood as described below.

Some compounds of the present invention have been 30 shown to inhibit aggrecanase, a key enzyme in cartilage breakdown, as determined by the aggrecanase assay described below.

The compounds of the present invention can be administered alone or in combination with one or more additional anti-inflammatory agents. These agents include, but are not limited to, selective COX-2 inhibitors, interleukin-1 antagonists, dihydroorotate synthase inhibitors, p38 MAP kinase inhibitors, TNF- $\alpha$  inhibitors, and TNF- $\alpha$  sequestration agents.

By "administered in combination" or "combination therapy" it is meant that a compound of the present invention and one or more additional therapeutic agents are administered concurrently to the mammal being treated. When administered in combination each component may be administered at the same time or sequentially in any order at different points in time. Thus, each component may be administered separately but sufficiently closely in time so as to provide the desired therapeutic effect.

The term selective COX-2 inhibitors, as used herein, denotes agents that selectively inhibit COX-2 function. Such agents include, but are not limited to, celecoxib (Celebrex<sup>®</sup>), rofecoxib (Vioxx<sup>®</sup>), meloxicam (Mobic<sup>®</sup>), etoricoxib, and valdecoxib.

TNF- $\alpha$  sequestration agents that may be used in combination with the compounds of this invention, are TNF- $\alpha$  binding proteins or anti-TNF- $\alpha$  antibodies. These agents include, but are not limited to, etanercept (Enbrel<sup>®</sup>), infliximab (Remicade<sup>®</sup>), adalimumab (D2E7), CDP-571 (Humicade<sup>®</sup>), and CDP-870.

Other anti-inflammatory agents that may be used in combination with the compounds of this invention, include, but are not limited to, methotrexate, interleukin-1

antagonists (e.g., anakinra (Kineret<sup>®</sup>)), dihydroorotate synthase inhibitors (e.g., leflunomide (Arava<sup>®</sup>)), and p38 MAP kinase inhibitors.

Administration of the compounds of the present invention (i.e., a first therapeutic agent) in combination with at least one additional therapeutic agent (i.e., a second therapeutic agent), preferably affords an efficacy advantage over the compounds and agents alone, preferably while permitting the use of lower doses of each (i.e., a synergistic combination). A lower dosage minimizes the potential of side effects, thereby providing an increased margin of safety. It is preferred that at least one of the therapeutic agents is administered in a sub-therapeutic dose. It is even more preferred that all of the therapeutic agents be administered in sub-therapeutic doses. Sub-therapeutic is intended to mean an amount of a therapeutic agent that by itself does not give the desired therapeutic effect for the condition or disease being treated. Synergistic combination is intended to mean that the observed effect of the combination is greater than the sum of the individual agents administered alone.

As used herein "µg" denotes microgram, "mg" denotes milligram, "g" denotes gram, "µL" denotes microliter, "mL" denotes milliliter, "L" denotes liter, "nM" denotes nanomolar, "µM" denotes micromolar, "mM" denotes millimolar, "M" denotes molar and "nm" denotes nanometer. "Sigma stands for the Sigma-Aldrich Corp. of St. Louis, MO.

A compound is considered to be active if it has an IC<sub>50</sub> or K<sub>i</sub> value of less than about 10 µM for the inhibition of a desired MP. Preferred compounds of the present invention have K<sub>i</sub>'s or IC<sub>50</sub>'s of ≤1 µM. More

preferred compounds of the present invention have  $K_i$ 's or  $IC_{50}$ 's of  $\leq 0.1 \mu M$ . Even more preferred compounds of the present invention have  $K_i$ 's or  $IC_{50}$ 's of  $\leq 0.01 \mu M$ . Still more preferred compounds of the present invention have  $K_i$ 's  
5 or  $IC_{50}$ 's of  $\leq 0.001 \mu M$ .

#### Aggrecanase Enzymatic Assay

A novel enzymatic assay was developed to detect potential inhibitors of aggrecanase. The assay uses active  
10 aggrecanase accumulated in media from stimulated bovine nasal cartilage (BNC) or related cartilage sources and purified cartilage aggrecan monomer or a fragment thereof as a substrate.

The substrate concentration, amount of aggrecanases  
15 time of incubation and amount of product loaded for Western analysis were optimized for use of this assay in screening putative aggrecanase inhibitors. Aggrecanase is generated by stimulation of cartilage slices with interleukin-1 (IL-1), tumor necrosis factor alpha (TNF- $\alpha$ ) or other stimuli.  
20 Matrix metalloproteinases (MMPs) are secreted from cartilage in an inactive, zymogen form following stimulation, although active enzymes are present within the matrix. We have shown that following depletion of the extracellular aggrecan matrix, active MMPs are released  
25 into the culture media (Tortorella, M.D. et al. *Trans. Ortho. Res. Soc.* **1995**, 20, 341). Therefore, in order to accumulate BNC aggrecanase in culture media, cartilage is first depleted of endogenous aggrecan by stimulation with 500 mg/ml human recombinant IL- $\beta$  for 6 days with media  
30 changes every 2 days. Cartilage is then stimulated for an additional 8 days without media change to allow accumulation of soluble, active aggrecanase in the culture

media. In order to decrease the amount of other matrix metalloproteinases released into the media during aggrecanase accumulation, agents which inhibit MMP-1, -2, -3, and -9 biosynthesis are included during stimulation.

5 This BNC conditioned media, containing aggrecanase activity is then used as the source of aggrecanase for the assay. Aggrecanase enzymatic activity is detected by monitoring production of aggrecan fragments produced exclusively by cleavage at the Glu373-Ala374 bond within the aggrecan core

10 protein by Western analysis using the monoclonal antibody, BC-3 (Hughes, CE, et al., Biochem J 306:799-804, 1995). This antibody recognizes aggrecan fragments with the N-terminus, 374ARGSVIL, generated upon cleavage by aggrecanase. The BC-3 antibody recognizes this neoepitope

15 only when it is at the N-terminus and not when it is present internally within aggrecan fragments or within the aggrecan protein core. Other proteases produced by cartilage in response to IL-1 do not cleave aggrecan at the Glu373-Ala374 aggrecanase site; therefore, only products

20 produced upon cleavage by aggrecanase are detected. Kinetic studies using this assay yield a  $K_m$  of  $1.5 \pm 0.35 \mu M$  for aggrecanase.

To evaluate inhibition of aggrecanase, compounds are prepared as 10 mM stocks in DMSO, water or other solvents

25 and diluted to appropriate concentrations in water. Drug (50  $\mu L$ ) is added to 50  $\mu L$  of aggrecanase-containing media and 50  $\mu L$  of 2 mg/ml aggrecan substrate and brought to a final volume of 200  $\mu L$  in 0.2 M Tris, pH 7.6, containing 0.4 M NaCl and 40 mM  $CaCl_2$ . The assay is run for 4 hr at

30 37 °C, quenched with 20 mM EDTA and analyzed for aggrecanase-generated products. A sample containing enzyme and substrate without drug is included as a positive



control and enzyme incubated in the absence of substrate serves as a measure of background.

Removal of the glycosaminoglycan side chains from aggrecan is necessary for the BC-3 antibody to recognize the ARGSVIL epitope on the core protein. Therefore, for analysis of aggrecan fragments generated by cleavage at the Glu373-Ala374 site, proteoglycans and proteoglycan fragments are enzymatically deglycosylated with chondroitinase ABC (0.1 units/10 µg GAG) for 2 hr at 37 °C and then with keratanase (0.1 units/10 µg GAG) and keratanase II (0.002 units/10 µg GAG) for 2 hr at 37 °C in buffer containing 50 mM sodium acetate, 0.1 M Tris/HCl, pH 6.5. After digestion, aggrecan in the samples is precipitated with 5 volumes of acetone and resuspended in 30 µL of Tris glycine SDS sample buffer (Novex®) containing 2.5% beta mercaptoethanol. Samples are loaded and then separated by SDS-PAGE under reducing conditions with 4-12% gradient gels, transferred to nitrocellulose and immunolocalized with 1:500 dilution of antibody BC3. Subsequently, membranes are incubated with a 1:5000 dilution of goat anti-mouse IgG alkaline phosphatase second antibody and aggrecan catabolites visualized by incubation with appropriate substrate for 10-30 minutes to achieve optimal color development. Blots are quantitated by scanning densitometry and inhibition of aggrecanase determined by comparing the amount of product produced in the presence versus absence of compound.

#### TNF PBMC ASSAY

Human peripheral blood mononuclear cells (PBMC) were obtained from normal donor blood by leukaphoresis and isolated by Ficoll-Paque density separation. PBMCs were

suspended in .5ml RPMI 1640 with no serum at  $2 \times 10^6$  cells/ml in 96 well polystyrene plates. Cells were preincubated 10 minutes with compound, then stimulated with 1 µg/ml LPS (Lipopolysaccharide, Salmonella typhimurium) to induce TNF production. After an incubation of 5 hours at 37 °C in 95% air, 5% CO<sub>2</sub> environment, culture supernatants were removed and tested by standard sandwich ELISA for TNF production.

10 TNF Human Whole Blood Assay

Blood is drawn from normal donors into tubes containing 143 USP units of heparin/10ml. 225ul of blood is plated directly into sterile polypropylene tubes. Compounds are diluted in DMSO/serum free media and added to the blood samples so the final concentration of compounds are 50, 10, 5, 1, .5, .1, and .01 µM. The final concentration of DMSO does not exceed 0.5%. Compounds are preincubated for 15 minutes before the addition of 100 mg/ml LPS. Plates are incubated for 5 hours in an atmosphere of 5% CO<sub>2</sub> in air. At the end of 5 hours, 750ul of serum free media is added to each tube and the samples are spun at 1200RPM for 10 minutes. The supernatant is collected off the top and assayed for TNF-alpha production by a standard sandwich ELISA. The ability of compounds to inhibit TNF-alpha production by 50% compared to DMSO treated cultures is given by the IC<sub>50</sub> value.

TNF Induction In Mice

Test compounds are administered to mice either I.P. or P.O. at time zero. Immediately following compound administration, mice receive an I.P. injection of 20 mg of D-galactosamine plus 10 µg of lipopolysaccharide. One hour

later, animals are anesthetized and bled by cardiac puncture. Blood plasma is evaluated for TNF levels by an ELISA specific for mouse TNF. Administration of representative compounds of the present invention to mice results in a dose-dependent suppression of plasma TNF levels at one hour in the above assay.

#### MMP ASSAYS

The enzymatic activities of recombinant MMP-1, 2, 3, 7, 8, 9, 10, 12, 13, 14, 15, and 16 were measured at 25°C with a fluorometric assay (Copeland, R.A. et al. *Bioorganic Med. Chem. Lett.* **1995**, 5, 1947-1952). Final enzyme concentrations in the assay were between 0.05 and 10 nM depending on the enzyme and the potency of the inhibitor tested. The permissive peptide substrate, MCA-Pro-Leu-Gly-Leu-DPA-Ala-Arg-NH<sub>2</sub>, was present at a final concentration of 10 µM in all assays. Initial velocities, in the presence or absence of inhibitor, were measured as slopes of the linear portion of the product progress curves. IC<sub>50</sub> values were determined by plotting the inhibitor concentration dependence of the fractional velocity for each enzyme, and fitting the data by non-linear least squares methods to the standard isotherm equation (Copeland, R.A. *Enzymes: A practical Introduction to Structure, Mechanism and Data Analysis*, Wiley-VHC, New York, **1996**, pp 187-223). All of the compounds studied here were assumed to act as competitive inhibitors of the enzyme, binding to the active site Zn atom as previously demonstrated by crystallographic studies of MMP-3 complexed with related hydroxamic acids (Rockwell, A. et al. *J. Am. Chem. Soc.* **1996**, 118, 10337-10338). Based on the

assumption of competitive inhibition, the IC<sub>50</sub> values were converted to K<sub>i</sub> values as previously described.

Compounds tested in the above assay are considered to be active if they exhibit a K<sub>i</sub> of  $\leq 10$   $\mu$ M. Preferred  
5 compounds of the present invention have K<sub>i</sub>'s of  $\leq 1$   $\mu$ M. More preferred compounds of the present invention have K<sub>i</sub>'s of  $\leq 0.1$   $\mu$ M. Even more preferred compounds of the present invention have K<sub>i</sub>'s of  $\leq 0.01$   $\mu$ M. Still more preferred compounds of the present invention have K<sub>i</sub>'s of  $\leq 0.001$   $\mu$ M.

10 Using the methodology described above, a number of compounds of the present invention were found to exhibit K<sub>i</sub>'s of  $\leq 10$   $\mu$ M, thereby confirming the utility of the compounds of the present invention.

The present invention also encompasses an article  
15 of manufacture. As used herein, article of manufacture is intended to include, but not be limited to, kits and packages. The article of manufacture of the present invention, comprises: (a) a first container; (b) a pharmaceutical composition located within the first  
20 container, wherein the composition, comprises: a first therapeutic agent, comprising: a compound of the present invention or a pharmaceutically acceptable salt form thereof; and, (c) a package insert stating that the pharmaceutical composition can be used for the treatment of  
25 an inflammatory disorder (as defined previously). In another embodiment, the package insert states that the pharmaceutical composition can be used in combination (as defined previously) with a second therapeutic agent to treat an inflammatory disorder. The article of manufacture  
30 can further comprise: (d) a second container, wherein components (a) and (b) are located within the second container and component (c) is located within or outside of

the second container. Located within the first and second containers means that the respective container holds the item within its boundaries.

The first container is a receptacle used to hold a pharmaceutical composition. This container can be for manufacturing, storing, shipping, and/or individual/bulk selling. First container is intended to cover a bottle, jar, vial, flask, syringe, tube (e.g., for a cream preparation), or any other container used to manufacture, hold, store, or distribute a pharmaceutical product.

The second container is one used to hold the first container and, optionally, the package insert. Examples of the second container include, but are not limited to, boxes (e.g., cardboard or plastic), crates, cartons, bags (e.g., paper or plastic bags), pouches, and sacks. The package insert can be physically attached to the outside of the first container via tape, glue, staple, or another method of attachment, or it can rest inside the second container without any physical means of attachment to the first container. Alternatively, the package insert is located on the outside of the second container. When located on the outside of the second container, it is preferable that the package insert is physically attached via tape, glue, staple, or another method of attachment. Alternatively, it can be adjacent to or touching the outside of the second container without being physically attached.

The package insert is a label, tag, marker, etc. that recites information relating to the pharmaceutical composition located within the first container. The information recited will usually be determined by the regulatory agency governing the area in which the article of manufacture is to be sold (e.g., the United States Food

and Drug Administration). Preferably, the package insert specifically recites the indications for which the pharmaceutical composition has been approved. The package insert may be made of any material on which a person can  
5' read information contained therein or thereon. Preferably, the package insert is a printable material (e.g., paper, plastic, cardboard, foil, adhesive-backed paper or plastic, etc.) on which the desired information has been formed (e.g., printed or applied).

10

#### Dosage and Formulation

The compounds of the present invention can be administered orally using any pharmaceutically acceptable dosage form known in the art for such administration. The  
15 active ingredient can be supplied in solid dosage forms such as dry powders, granules, tablets or capsules, or in liquid dosage forms, such as syrups or aqueous suspensions. The active ingredient can be administered alone, but is generally administered with a pharmaceutical carrier. A  
20 valuable treatise with respect to pharmaceutical dosage forms is Remington's Pharmaceutical Sciences, Mack Publishing.

The compounds of the present invention can be administered in such oral dosage forms as tablets, capsules  
25 (each of which includes sustained release or timed release formulations), pills, powders, granules, elixirs, tinctures, suspensions, syrups, and emulsions. Likewise, they may also be administered in intravenous (bolus or infusion), intraperitoneal, subcutaneous, or intramuscular  
30 form, all using dosage forms well known to those of ordinary skill in the pharmaceutical arts. An effective

but non-toxic amount of the compound desired can be employed as an antiinflammatory and antiarthritic agent.

The compounds of this invention can be administered by any means that produces contact of the active agent with the agent's site of action in the body of a mammal. They can be administered by any conventional means available for use in conjunction with pharmaceuticals, either as individual therapeutic agents or in a combination of therapeutic agents. They can be administered alone, but generally administered with a pharmaceutical carrier selected on the basis of the chosen route of administration and standard pharmaceutical practice.

The dosage regimen for the compounds of the present invention will, of course, vary depending upon known factors, such as the pharmacodynamic characteristics of the particular agent and its mode and route of administration; the species, age, sex, health, medical condition, and weight of the recipient; the nature and extent of the symptoms; the kind of concurrent treatment; the frequency of treatment; the route of administration, the renal and hepatic function of the patient, and the effect desired. An ordinarily skilled physician or veterinarian can readily determine and prescribe the effective amount of the drug required to prevent, counter, or arrest the progress of the condition.

By way of general guidance, the daily oral dosage of each active ingredient, when used for the indicated effects, will range between about 0.001 to 1000 mg/kg of body weight, preferably between about 0.01 to 100 mg/kg of body weight per day, and most preferably between about 1.0 to 20 mg/kg/day. For a normal male adult human of approximately 70 kg of body weight, this translates into a

dosage of 70 to 1400 mg/day. Intravenously, the most preferred doses will range from about 1 to about 10 mg/kg/minute during a constant rate infusion.

Advantageously, compounds of the present invention may be administered in a single daily dose, or the total daily dosage may be administered in divided doses of two, three, or four times daily.

The compounds for the present invention can be administered in intranasal form via topical use of suitable intranasal vehicles, or via transdermal routes, using those forms of transdermal skin patches well known to those of ordinary skill in that art. To be administered in the form of a transdermal delivery system, the dosage administration will, of course, be continuous rather than intermittent throughout the dosage regimen.

In the methods of the present invention, the compounds herein described in detail can form the active ingredient, and are typically administered in admixture with suitable pharmaceutical diluents, excipients, or carriers (collectively referred to herein as carrier materials) suitably selected with respect to the intended form of administration, that is, oral tablets, capsules, elixirs, syrups and the like, and consistent with conventional pharmaceutical practices.

For instance, for oral administration in the form of a tablet or capsule, the active drug component can be combined with an oral, non-toxic, pharmaceutically acceptable, inert carrier such as lactose, starch, sucrose, glucose, methyl cellulose, magnesium stearate, dicalcium phosphate, calcium sulfate, mannitol, sorbitol and the like; for oral administration in liquid form, the oral drug components can be combined with any oral, non-toxic,



pharmaceutically acceptable inert carrier such as ethanol, glycerol, water, and the like. Moreover, when desired or necessary, suitable binders, lubricants, disintegrating agents, and coloring agents can also be incorporated into the mixture. Suitable binders include starch, gelatin, natural sugars such as glucose or beta-lactose, corn sweeteners, natural and synthetic gums such as acacia, tragacanth, or sodium alginate, carboxymethylcellulose, polyethylene glycol, waxes, and the like. Lubricants used in these dosage forms include sodium oleate, sodium stearate, magnesium stearate, sodium benzoate, sodium acetate, sodium chloride, and the like. Disintegrators include, without limitation, starch, methyl cellulose, agar, bentonite, xanthan gum, and the like.

The compounds of the present invention can also be administered in the form of liposome delivery systems, such as small unilamellar vesicles, large unilamellar vesicles, and multilamellar vesicles. Liposomes can be formed from a variety of phospholipids, such as cholesterol, stearylamine, or phosphatidylcholines.

Compounds of the present invention may also be coupled with soluble polymers as targetable drug carriers. Such polymers can include polyvinylpyrrolidone, pyran copolymer, polyhydroxypropylmethacrylamide-phenol, polyhydroxyethylaspartamidephenol, or polyethyleneoxide-polylysine substituted with palmitoyl residues.

Furthermore, the compounds of the present invention may be coupled to a class of biodegradable polymers useful in achieving controlled release of a drug, for example, polylactic acid, polyglycolic acid, copolymers of polylactic and polyglycolic acid, polyepsilon caprolactone, polyhydroxy butyric acid, polyorthoesters, polyacetals,

polydihydropyrans, polycyanoacylates, and crosslinked or amphipathic block copolymers of hydrogels.

Dosage forms (pharmaceutical compositions) suitable for administration may contain from about 1 milligram to  
5 about 100 milligrams of active ingredient per dosage unit. In these pharmaceutical compositions the active ingredient will ordinarily be present in an amount of about 0.5-95% by weight based on the total weight of the composition.

The active ingredient can be administered orally in  
10 solid dosage forms, such as capsules, tablets, and powders, or in liquid dosage forms, such as elixirs, syrups, and suspensions. It can also be administered parenterally, in sterile liquid dosage forms.

Gelatin capsules may contain the active ingredient and  
15 powdered carriers, such as lactose, starch, cellulose derivatives, magnesium stearate, stearic acid, and the like. Similar diluents can be used to make compressed tablets. Both tablets and capsules can be manufactured as sustained release products to provide for continuous  
20 release of medication over a period of hours. Compressed tablets can be sugar coated or film coated to mask any unpleasant taste and protect the tablet from the atmosphere, or enteric coated for selective disintegration in the gastrointestinal tract.

25 Liquid dosage forms for oral administration can contain coloring and flavoring to increase patient acceptance. In general, water, a suitable oil, saline, aqueous dextrose (glucose), and related sugar solutions and glycols such as propylene glycol or polyethylene glycols are suitable  
30 carriers for parenteral solutions. Solutions for parenteral administration preferably contain a water soluble salt of the active ingredient, suitable stabilizing

agents, and if necessary, buffer substances. Antioxidizing agents such as sodium bisulfite, sodium sulfite, or ascorbic acid, either alone or combined, are suitable stabilizing agents. Also used are citric acid and its salts and sodium EDTA. In addition, parenteral solutions can contain preservatives, such as benzalkonium chloride, methyl- or propyl-paraben, and chlorobutanol.

Suitable pharmaceutical carriers are described in Remington's Pharmaceutical Sciences, Mack Publishing Company, a standard reference text in this field. Useful pharmaceutical dosage-forms for administration of the compounds of this invention can be illustrated as follows:

#### Capsules

Capsules are prepared by conventional procedures so that the dosage unit is 500 milligrams of active ingredient, 100 milligrams of cellulose and 10 milligrams of magnesium stearate.

A large number of unit capsules may also prepared by filling standard two-piece hard gelatin capsules each with 100 milligrams of powdered active ingredient, 150 milligrams of lactose, 50 milligrams of cellulose, and 6 milligrams magnesium stearate.

Syrup

		<u>Wt. %</u>
	Active Ingredient	10
5	Liquid Sugar	50
	Sorbitol	20
	Glycerine	5
	Flavor, Colorant and Preservative	as required
	Water	as required
10		

The final volume is brought up to 100% by the addition of distilled water.

Aqueous Suspension

		<u>Wt. %</u>
15	Active Ingredient	10
	Sodium Saccharin	0.01
	Keltrol® (Food Grade Xanthan Gum)	0.2
	Liquid Sugar	5
20	Flavor, Colorant and Preservative	as required
	Water	as required

Xanthan gum is slowly added into distilled water before adding the active ingredient and the rest of the formulation ingredients. The final suspension is passed through a homogenizer to assure the elegance of the final products.

Resuspendable Powder

		<u>Wt. %</u>
	Active Ingredient	50.0
5	Lactose	35.0
	Sugar	10.0
	Acacia	4.7
	Sodium Carboxymethylcellulose	0.3

10        Each ingredient is finely pulverized and then uniformly mixed together. Alternatively, the powder can be prepared as a suspension and then spray dried.

Semi-Solid Gel

		<u>Wt. %</u>
15	Active Ingredient	10
	Sodium Saccharin	0.02
	Gelatin	2
	Flavor, Colorant and Preservative	as required
	Water	as required

20

      Gelatin is prepared in hot water. The finely pulverized active ingredient is suspended in the gelatin solution and then the rest of the ingredients are mixed in. The suspension is filled into a suitable packaging

25    container and cooled down to form the gel.

Semi-Solid Paste

		<u>Wt. %</u>
	Active Ingredient	10
5	Gelcarin® (Carrageenin gum)	1
	Sodium Saccharin	0.01
	Gelatin	2
	Flavor, Colorant and Preservative	as required
	Water	as required
10		

Gelcarin® is dissolved in hot water (around 80°C) and then the fine-powder active ingredient is suspended in this solution. Sodium saccharin and the rest of the formulation ingredients are added to the suspension while it is still  
15 warm. The suspension is homogenized and then filled into suitable containers.

Emulsifiable Paste

		<u>Wt. %</u>
20	Active Ingredient	30
	Tween® 80 and Span® 80	6
	Keltrol®	0.5
	Mineral Oil	63.5

25 All the ingredients are carefully mixed together to make a homogenous paste.

Soft Gelatin Capsules

A mixture of active ingredient in a digestible oil  
30 such as soybean oil, cottonseed oil or olive oil is prepared and injected by means of a positive displacement pump into gelatin to form soft gelatin capsules containing

100 milligrams of the active ingredient. The capsules are washed and dried.

#### Tablets

5           Tablets may be prepared by conventional procedures so that the dosage unit is 500 milligrams of active ingredient, 150 milligrams of lactose, 50 milligrams of cellulose and 10 milligrams of magnesium stearate.

          A large number of tablets may also be prepared by  
10       conventional procedures so that the dosage unit was 100 milligrams of active ingredient, 0.2 milligrams of colloidal silicon dioxide, 5 milligrams of magnesium stearate, 275 milligrams of microcrystalline cellulose, 11 milligrams of starch and 98.8 milligrams of lactose.  
15       Appropriate coatings may be applied to increase palatability or delay absorption.

#### Injectable

          A parenteral composition suitable for administration  
20       by injection is prepared by stirring 1.5% by weight of active ingredient in 10% by volume propylene glycol and water. The solution is made isotonic with sodium chloride and sterilized.

#### Suspension

25           An aqueous suspension is prepared for oral administration so that each 5 mL contain 100 mg of finely divided active ingredient, 200 mg of sodium carboxymethyl cellulose, 5 mg of sodium benzoate, 1.0 g of sorbitol  
30       solution, U.S.P.; and 0.025 mL of vanillin.

          The compounds of the present invention may be administered in combination with a second therapeutic

agent, especially non-steroidal anti-inflammatory drugs (NSAID's). The compound of Formula I and such second therapeutic agent can be administered separately or as a physical combination in a single dosage unit, in any dosage form and by various routes of administration, as described above.

The compound of Formula I may be formulated together with the second therapeutic agent in a single dosage unit (that is, combined together in one capsule, tablet, powder, or liquid, etc.). When the compound of Formula I and the second therapeutic agent are not formulated together in a single dosage unit, the compound of Formula I and the second therapeutic agent may be administered essentially at the same time, or in any order; for example the compound of Formula I may be administered first, followed by administration of the second agent. When not administered at the same time, preferably the administration of the compound of Formula I and the second therapeutic agent occurs less than about one hour apart, more preferably less than about 5 to 30 minutes apart.

Preferably the route of administration of the compound of Formula I is oral. Although it is preferable that the compound of Formula I and the second therapeutic agent are both administered by the same route (that is, for example, both orally), if desired, they may each be administered by different routes and in different dosage forms (that is, for example, one component of the combination product may be administered orally, and another component may be administered intravenously).

The dosage of the compound of Formula I when administered alone or in combination with a second therapeutic agent may vary depending upon various factors



such as the pharmacodynamic characteristics of the particular agent and its mode and route of administration, the age, health and weight of the recipient, the nature and extent of the symptoms, the kind of concurrent treatment,  
5 the frequency of treatment, and the effect desired, as described above.

Particularly when provided as a single dosage unit, the potential exists for a chemical interaction between the combined active ingredients. For this reason, when the  
10 compound of Formula I and a second therapeutic agent are combined in a single dosage unit they are formulated such that although the active ingredients are combined in a single dosage unit, the physical contact between the active ingredients is minimized (that is, reduced). For example,  
15 one active ingredient may be enteric coated. By enteric coating one of the active ingredients, it is possible not only to minimize the contact between the combined active ingredients, but also, it is possible to control the release of one of these components in the gastrointestinal  
20 tract such that one of these components is not released in the stomach but rather is released in the intestines. One of the active ingredients may also be coated with a sustained-release material which effects a sustained-release throughout the gastrointestinal tract and also  
25 serves to minimize physical contact between the combined active ingredients. Furthermore, the sustained-released component can be additionally enteric coated such that the release of this component occurs only in the intestine. Still another approach would involve the formulation of a  
30 combination product in which the one component is coated with a sustained and/or enteric release polymer, and the other component is also coated with a polymer such as a

lowviscosity grade of hydroxypropyl methylcellulose (HPMC) or other appropriate materials as known in the art, in order to further separate the active components. The polymer coating serves to form an additional barrier to  
5 interaction with the other component.

These as well as other ways of minimizing contact between the components of combination products of the present invention, whether administered in a single dosage form or administered in separate forms but at the same time  
10 by the same manner, will be readily apparent to those skilled in the art, once armed with the present disclosure.

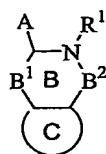
The present invention also includes pharmaceutical kits useful, for example, in the treatment or prevention of osteoarthritis or rheumatoid arthritis, which comprise one  
15 or more containers containing a pharmaceutical composition comprising a therapeutically effective amount of a compound of Formula I. Such kits may further include, if desired, one or more of various conventional pharmaceutical kit components, such as, for example, containers with one or  
20 more pharmaceutically acceptable carriers, additional containers, etc., as will be readily apparent to those skilled in the art. Instructions, either as inserts or as labels, indicating quantities of the components to be administered, guidelines for administration, and/or  
25 guidelines for mixing the components, may also be included in the kit.

In the present disclosure it should be understood that the specified materials and conditions are important in practicing the invention but that unspecified materials and  
30 conditions are not excluded so long as they do not prevent the benefits of the invention from being realized.

Although this invention has been described with respect to specific embodiments, the details of these embodiments are not to be construed as limitations. Various equivalents, changes and modifications may be made  
5 without departing from the spirit and scope of this invention, and it is understood that such equivalent embodiments are part of this invention.

WHAT IS CLAIMED IS:

1. A compound of formula I:



I

5 or a stereoisomer or pharmaceutically acceptable salt form thereof, wherein;

A is selected from:  $-C(O)NHOH$ ,  $-C(O)NHOR^5$ ,  $-C(O)NHOR^6$ ,  
 $-N(OH)COR^5$ ,  $-N(OH)CHO$ , and  $-CH_2SH$ ;

10

ring B, including  $B^1$  and  $B^2$ , is a 5-7 membered heterocyclic ring substituted with 0-1  $R^2$ ;

$B^1$  and  $B^2$ , independently of one another, consist of 0-3  
 15 carbon atoms and 0-1 heteroatoms selected from O, N, and  $S(O)_p$  and are substituted with 0-1 carbonyl groups;

provided that ring B contains other than a N-S, N-O, or N-N  
 20 bond;

ring C is a 5-10 membered aromatic ring consisting of 1-9  
 carbon atoms and 0-4 heteroatoms selected from O, N, and  $S(O)_p$ ;

25

ring C is substituted with 0-1  $R^3$  and 0-1  $R^4$ ;

$R^1$  is  $U-X-Y-Z-U^a-X^a-Y^a-Z^a$ ;

- U is selected from: C(O), C(O)O, C(O)NR<sup>a1</sup>, S(O)<sub>p</sub>, and S(O)<sub>p</sub>NR<sup>a1</sup>;
- X is absent or is selected from: C<sub>1-10</sub> alkylene, C<sub>2-10</sub> alkenylene, and C<sub>2-10</sub> alkynylene;
- Y is absent or is selected from: O, NR<sup>a1</sup>, S(O)<sub>p</sub>, and C(O);
- Z is selected from:
- a C<sub>3-13</sub> carbocycle substituted with 0-5 R<sup>b</sup>; and  
a 5-14 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-5 R<sup>b</sup>;
- U<sup>a</sup> is absent or is selected from: O, NR<sup>a1</sup>, C(O), C(O)O, OC(O), C(O)NR<sup>a1</sup>, NR<sup>a1</sup>C(O), OC(O)O, OC(O)NR<sup>a1</sup>, NR<sup>a1</sup>C(O)O, NR<sup>a1</sup>C(O)NR<sup>a1</sup>, S(O)<sub>p</sub>, S(O)<sub>p</sub>NR<sup>a1</sup>, NR<sup>a1</sup>S(O)<sub>p</sub>, and NR<sup>a1</sup>SO<sub>2</sub>NR<sup>a1</sup>;
- X<sup>a</sup> is absent or is selected from: C<sub>1-4</sub> alkylene, C<sub>2-4</sub> alkenylene, and C<sub>2-4</sub> alkynylene;
- Y<sup>a</sup> is absent or is selected from: O, NR<sup>a1</sup>, S(O)<sub>p</sub>, and C(O);
- provided that U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup> forms a spacer of two or more atoms, other than -CH=CH- or -C≡C-;
- Z<sup>a</sup> is selected from:
- a C<sub>3-13</sub> carbocycle substituted with 0-5 R<sup>c</sup>; and

a 5-14 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-5 R<sup>c</sup>;

5 provided that U, Y, Z, U<sup>a</sup>, Y<sup>a</sup>, and Z<sup>a</sup> do not combine to form a N-N, N-O, O-N, O-O, S(O)<sub>p</sub>-O, O-S(O)<sub>p</sub> or S(O)<sub>p</sub>-S(O)<sub>p</sub> group;

R<sup>2</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>b</sup>,  
10 C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>b</sup>, and C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>b</sup>;

R<sup>3</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>b</sup>,  
C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>b</sup>,  
15 C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>b</sup>,  
C<sub>3-10</sub> carbocycle substituted with 0-2 R<sup>b</sup>,  
-(CH<sub>2</sub>)<sub>r</sub>-C<sub>3-10</sub> carbocycle substituted with 0-2 R<sup>b</sup>, and  
-(CH<sub>2</sub>)<sub>r</sub>-5-10 membered heterocycle consisting of carbon  
atoms and 1-4 heteroatoms selected from the group  
20 consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-2 R<sup>b</sup>;

R<sup>4</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>b</sup>,  
C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>b</sup>, C<sub>2-6</sub> alkynyl  
25 substituted with 0-1 R<sup>b</sup>, OR<sup>a</sup>, Cl, F, Br, I, =O, -CN,  
NO<sub>2</sub>, NR<sup>a</sup>R<sup>a1</sup>, C(O)R<sup>a</sup>, C(O)OR<sup>a</sup>, C(O)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)R<sup>a</sup>,  
C(S)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)NR<sup>a</sup>R<sup>a1</sup>, OC(O)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)OR<sup>a</sup>,  
S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>S(O)<sub>2</sub>R<sup>a3</sup>, NR<sup>a</sup>S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, OS(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>,  
NR<sup>a</sup>S(O)<sub>2</sub>R<sup>a3</sup>, S(O)<sub>p</sub>R<sup>a3</sup>, CF<sub>3</sub>, OCF<sub>3</sub>, and CF<sub>2</sub>CF<sub>3</sub>;

30

$R^a$ , at each occurrence, is independently selected from: H  
and  $C_{1-6}$  alkyl;

$R^{a1}$ , at each occurrence, is independently selected from: H,  
5  $C_{1-6}$  alkyl substituted with 0-1  $R^{c1}$ ,  
 $C_{2-6}$  alkenyl substituted with 0-1  $R^{c1}$ ,  
 $C_{2-6}$  alkynyl substituted with 0-1  $R^{c1}$ , and  
-(CH<sub>2</sub>)<sub>r</sub>-3-8 membered carbocyclic or heterocyclic ring  
consisting of carbon atoms and 0-2 ring heteroatoms  
10 selected from N,  $NR^{a2}$ , O, and S(O)<sub>p</sub> and substituted  
with 0-3  $R^{c1}$ ;

alternatively,  $R^a$  and  $R^{a1}$  when attached to a nitrogen are  
taken together with the nitrogen to which they are  
15 attached form a 5 or 6 membered heterocycle consisting  
of carbon atoms and from 0-1 additional heteroatoms  
selected from N,  $NR^{a2}$ , O, and S(O)<sub>p</sub>;

$R^{a2}$ , at each occurrence, is independently selected from:  
20  $C_{1-4}$  alkyl, phenyl, and benzyl;

$R^{a3}$ , at each occurrence, is independently selected from: H,  
 $C_{1-6}$  alkyl substituted with 0-1  $R^{c1}$ ,  
 $C_{2-6}$  alkenyl substituted with 0-1  $R^{c1}$ ,  
25  $C_{2-6}$  alkynyl substituted with 0-1  $R^{c1}$ ,  
-(CH<sub>2</sub>)<sub>r</sub>-3-8 membered carbocyclic or heterocyclic ring  
consisting of carbon atoms and 0-2 ring heteroatoms  
selected from N,  $NR^{a2}$ , O, and S(O)<sub>p</sub> and substituted  
with 0-3  $R^{c1}$ ;

30

$R^b$ , at each occurrence, is independently selected from:

$C_{1-6}$  alkyl substituted with 0-1  $R^{c1}$ ,  $OR^a$ , Cl, F, Br, I, =O, -CN,  $NO_2$ ,  $NR^aR^{a1}$ ,  $C(O)R^a$ ,  $C(O)OR^a$ ,  $C(O)NR^aR^{a1}$ ,  $NR^aC(O)R^a$ ,  $C(S)NR^aR^{a1}$ ,  $NR^aC(O)NR^aR^{a1}$ ,  $OC(O)NR^aR^{a1}$ ,  
 5  $NR^aC(O)OR^a$ ,  $S(O)_2NR^aR^{a1}$ ,  $NR^aS(O)_2R^{a3}$ ,  $NR^aS(O)_2NR^aR^{a1}$ ,  $OS(O)_2NR^aR^{a1}$ ,  $NR^aS(O)_2R^{a3}$ ,  $S(O)_pR^{a3}$ ,  $CF_3$ ,  $OCF_3$ ,  $CF_2CF_3$ ,  $CHF_2$ ,  $CH_2F$ , and phenyl;

$R^c$ , at each occurrence, is independently selected from: H,

10  $C_{1-6}$  alkyl substituted with 0-2  $R^{c1}$ ,  $C_{2-6}$  alkenyl substituted with 0-2  $R^{c1}$ ,  $C_{2-6}$  alkynyl substituted with 0-2  $R^{c1}$ ,  $OR^a$ , Cl, F, Br, I, =O, -CN,  $NO_2$ ,  $CF_3$ ,  $CF_2CF_3$ ,  $CH_2F$ ,  $CHF_2$ ,  $(CR^aR^{a1})_nNR^aR^{a1}$ ,  
 15  $(CR^aR^{a1})_nC(=NCN)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nC(=NR^a)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nC(=NOR^a)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nC(O)NR^aOH$ ,  $(CR^aR^{a1})_nC(O)R^{a1}$ ,  $(CR^aR^{a1})_nC(O)OR^{a1}$ ,  $(CR^aR^{a1})_nC(S)OR^{a1}$ ,  $(CR^aR^{a1})_nC(O)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nNR^aC(O)R^{a1}$ ,  $(CR^aR^{a1})_nC(S)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nOC(O)NR^aR^{a1}$ ,  $(CR^aR^{a1})_nNR^aC(O)OR^{a1}$ ,  $(CR^aR^{a1})_nNR^aC(O)NR^aR^{a1}$ ,  
 20  $(CR^aR^{a1})_nS(O)_pR^{a3}$ ,  $(CR^aR^{a1})_nSO_2NR^aR^{a1}$ ,  $(CR^aR^{a1})_nNR^aSO_2R^{a3}$ ,  $(CR^aR^{a1})_nNR^aSO_2NR^aR^{a1}$ ,  
 -  $(CR^aR^{a1})_n-C_{3-10}$  carbocycle substituted with 0-2  $R^{c1}$ ,  
 and  
 -  $(CR^aR^{a1})_n-5-14$  membered heterocycle consisting of  
 25 carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and  $S(O)_p$  and substituted with 0-2  $R^{c1}$ ;



- $R^{c1}$ , at each occurrence, is independently selected from: H, C<sub>1-4</sub> alkyl, OR<sup>a</sup>, Cl, F, Br, I, =O, CF<sub>3</sub>, -CN, NO<sub>2</sub>, C(O)R<sup>a</sup>, C(O)OR<sup>a</sup>, C(O)NR<sup>a</sup>R<sup>a</sup>, and S(O)<sub>p</sub>R<sup>a</sup>;
- 5  $R^5$ , at each occurrence, is selected from: C<sub>1-10</sub> alkyl substituted with 0-2 R<sup>b</sup>, and C<sub>1-8</sub> alkyl substituted with 0-2 R<sup>e</sup>;
- $R^e$ , at each occurrence, is selected from: phenyl  
 10 substituted with 0-2 R<sup>b</sup> and biphenyl substituted with 0-2 R<sup>b</sup>;
- $R^6$ , at each occurrence, is selected from: phenyl, naphthyl, C<sub>1-10</sub> alkyl-phenyl-C<sub>1-6</sub> alkyl-, C<sub>3-11</sub> cycloalkyl, C<sub>1-6</sub>  
 15 alkylcarbonyloxy-C<sub>1-3</sub> alkyl-, C<sub>1-6</sub> alkoxy carbonyloxy-C<sub>1-3</sub> alkyl-, C<sub>2-10</sub> alkoxy carbonyl, C<sub>3-6</sub> cycloalkylcarbonyloxy-C<sub>1-3</sub> alkyl-, C<sub>3-6</sub> cycloalkoxy carbonyloxy-C<sub>1-3</sub> alkyl-, C<sub>3-6</sub> cycloalkoxy carbonyl, phenoxycarbonyl,  
 20 phenyloxy carbonyloxy-C<sub>1-3</sub> alkyl-, phenylcarbonyloxy-C<sub>1-3</sub> alkyl-, C<sub>1-6</sub> alkoxy-C<sub>1-6</sub> alkylcarbonyloxy-C<sub>1-3</sub> alkyl-, [5-(C<sub>1</sub>-C<sub>5</sub> alkyl)-1,3-dioxo-cyclopenten-2-one-yl]methyl, [5-(R<sup>a</sup>)-1,3-dioxo-cyclopenten-2-one-yl]methyl,  
 25 (5-aryl-1,3-dioxo-cyclopenten-2-one-yl)methyl, -C<sub>1-10</sub> alkyl-NR<sup>7</sup>R<sup>7a</sup>, -CH(R<sup>8</sup>)OC(=O)R<sup>9</sup>, and -CH(R<sup>8</sup>)OC(=O)OR<sup>9</sup>;
- $R^7$  is selected from: H, C<sub>1-10</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>3-6</sub> cycloalkyl-C<sub>1-3</sub> alkyl-, and phenyl-C<sub>1-6</sub> alkyl-;
- 30

R<sup>7a</sup> is selected from H, C<sub>1-10</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>3-6</sub> cycloalkyl-C<sub>1-3</sub> alkyl-, and phenyl-C<sub>1-6</sub> alkyl-;

R<sup>8</sup> is selected from H and C<sub>1-4</sub> linear alkyl;

5

R<sup>9</sup> is selected from H, C<sub>1-8</sub> alkyl substituted with 1-2 R<sup>f</sup>, C<sub>3-8</sub> cycloalkyl substituted with 1-2 R<sup>f</sup>, and phenyl substituted with 0-2 R<sup>b</sup>;

10 R<sup>f</sup>, at each occurrence, is selected from: C<sub>1-4</sub> alkyl, C<sub>3-8</sub> cycloalkyl, C<sub>1-5</sub> alkoxy, and phenyl substituted with 0-2 R<sup>b</sup>;

n, at each occurrence, is selected from: 0, 1, 2, 3, and 4;

15

p, at each occurrence, is selected from: 0, 1, and 2; and

r, at each occurrence, is selected from: 0, 1, 2, 3, and 4;

20 provided that:

- (i) when rings B and C form tetrahydroisoquinoline and A is -C(O)NHOH, then R<sup>1</sup> is other than {4-((2-methyl-4-quinolinyl)methoxy)phenyl}acetyl, {2-hydroxybenzoyl}amino}benzenesulfonyl, 25 {4-fluorophenyl)methoxy}benzenesulfonyl, or {4-methoxyphenyl}carbamate}benzenesulfonyl;
- (ii) when rings B and C form tetrahydro-furo[2,3-c]pyridine, A is -C(O)NHOH, and U is SO<sub>2</sub>, then Z is other than phenyl;
- 30 (iii) when rings B and C form tetrahydro-1H-[1,4]benzodiazepine, A is -C(O)NHOH, U is SO<sub>2</sub>,

then Z is other than phenyl;

(iv) when U is SO<sub>2</sub>, then U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup> is other than  
-OCH<sub>2</sub>-C≡C-, -NHCH<sub>2</sub>-C≡C-, -CH<sub>2</sub>CH<sub>2</sub>-C≡C- or  
-SCH<sub>2</sub>-C≡C-;

5 (v) when U is SO<sub>2</sub> and Z is phenyl, then U<sup>a</sup> is other  
than OC(O).

2. A compound according to Claim 1, wherein;

10

A is selected from: -C(O)NHOH, -C(O)NHOR<sup>5</sup>, -C(O)NHOR<sup>6</sup>,  
-N(OH)COR<sup>5</sup>, and -N(OH)CHO;

15 ring B including B<sup>1</sup> and B<sup>2</sup> is a 5-6 membered heterocyclic  
ring substituted with 0-1 R<sup>2</sup>;

ring C is a 6 membered aryl or 5-6 membered heteroaryl  
consisting of 1-6 carbon atoms and 0-4 heteroatoms  
selected from O, N, and S(O)<sub>p</sub>;

20

ring C is substituted with 0-1 R<sup>3</sup> and 0-1 R<sup>4</sup>;

X is absent or is selected from: C<sub>1-4</sub> alkylene, C<sub>2-4</sub>  
alkenylene, and C<sub>2-4</sub> alkynylene;

25

Y is absent;

Z is selected from:

a C<sub>3-11</sub> carbocycle substituted with 0-5 R<sup>b</sup>; and

a 5-11 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-5 R<sup>b</sup>;

5 U<sup>a</sup> is absent or is selected from: O, NR<sup>a1</sup>, C(O), C(O)O, C(O)NR<sup>a1</sup>, NR<sup>a1</sup>C(O), S(O)<sub>p</sub>, and S(O)<sub>p</sub>NR<sup>a1</sup>;

X<sup>a</sup> is absent or is selected from: C<sub>1-4</sub> alkylene, C<sub>2</sub> alkenylene, and C<sub>2</sub> alkynylene;

10

Y<sup>a</sup> is absent or is selected from: O and NR<sup>a1</sup>;

provided that U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup> forms a spacer of two or more atoms, other than -CH=CH- or -C≡C-;

15

Z<sup>a</sup> is selected from:

a C<sub>3-13</sub> carbocycle substituted with 0-5 R<sup>c</sup>; and  
a 5-10 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting  
20 of N, O, and S(O)<sub>p</sub> and substituted with 0-5 R<sup>c</sup>;

provided that U, Z, U<sup>a</sup>, Y<sup>a</sup>, and Z<sup>a</sup> do not combine to form a N-N, N-O, O-N, O-O, S(O)<sub>p</sub>-O, O-S(O)<sub>p</sub> or S(O)<sub>p</sub>-S(O)<sub>p</sub> group;

25

R<sup>3</sup> is selected from: H, C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>b</sup>,  
C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>b</sup>,  
C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>b</sup>,  
C<sub>3-6</sub> carbocycle substituted with 0-2 R<sup>b</sup>,  
30 -CH<sub>2</sub>-C<sub>3-6</sub> carbocycle substituted with 0-2 R<sup>b</sup>,

a 5-6 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-2 R<sup>b</sup>, and  
 5 -CH<sub>2</sub>-5-6 membered heterocycle consisting of carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and S(O)<sub>p</sub> and substituted with 0-2 R<sup>b</sup>;

R<sup>a</sup>, at each occurrence, is independently selected from: H  
 10 and C<sub>1-4</sub> alkyl;

R<sup>a1</sup>, at each occurrence, is independently selected from: H, C<sub>1-4</sub> alkyl, phenyl and benzyl;

15 alternatively, R<sup>a</sup> and R<sup>a1</sup> when attached to a nitrogen are taken together with the nitrogen to which they are attached form a 5 or 6 membered heterocycle consisting of carbon atoms and from 0-1 additional heteroatoms selected from N, NR<sup>a2</sup>, O, and S(O)<sub>p</sub>;

20 R<sup>b</sup>, at each occurrence, is independently selected from: C<sub>1-6</sub> alkyl, OR<sup>a</sup>, Cl, F, Br, =O, -CN, NR<sup>a</sup>R<sup>a1</sup>, C(O)R<sup>a</sup>, C(O)OR<sup>a</sup>, C(O)NR<sup>a</sup>R<sup>a1</sup>, NR<sup>a</sup>C(O)R<sup>a</sup>, S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, S(O)<sub>p</sub>R<sup>a3</sup>, CF<sub>3</sub>, and OCF<sub>3</sub>;

25 R<sup>c</sup>, at each occurrence, is independently selected from: C<sub>1-6</sub> alkyl substituted with 0-1 R<sup>c1</sup>, C<sub>2-6</sub> alkenyl substituted with 0-1 R<sup>c1</sup>, C<sub>2-6</sub> alkynyl substituted with 0-1 R<sup>c1</sup>, OR<sup>a</sup>, Cl, F, Br, =O, -CN, NR<sup>a</sup>R<sup>a1</sup>, CF<sub>3</sub>,  
 30 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)OR<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)NR<sup>a</sup>R<sup>a1</sup>,

$(CR^aRa^1)_nS(O)_pRa^3$ ,  $(CR^aRa^1)_nSO_2NR^aRa^1$ ,  $C_{3-6}$  carbocycle and a 5-6 membered heterocycle comprising carbon atoms and 1-4 heteroatoms selected from the group consisting of N, O, and  $S(O)_p$ ;

5

$R^5$ , at each occurrence, is selected from:  $C_{1-6}$  alkyl substituted with 0-2  $R^b$ , and  $C_{1-4}$  alkyl substituted with 0-2  $R^e$ ;

10  $R^7$  is selected from: H,  $C_{1-6}$  alkyl,  $C_{2-6}$  alkenyl,  $C_{3-6}$  cycloalkyl- $C_{1-3}$  alkyl-, and phenyl- $C_{1-6}$  alkyl-;

$R^{7a}$  is selected from: H,  $C_{1-6}$  alkyl,  $C_{2-6}$  alkenyl,  $C_{3-6}$  cycloalkyl- $C_{1-3}$  alkyl-, and phenyl- $C_{1-6}$  alkyl-; and

15

$R^9$  is selected from: H,  $C_{1-6}$  alkyl substituted with 1-2  $R^f$ ,  $C_{3-6}$  cycloalkyl substituted with 1-2  $R^f$ , and phenyl substituted with 0-2  $R^b$ ;

20 provided that:

- (i) when rings B and C form tetrahydroisoquinoline and A is  $-C(O)NHOH$ , then  $R^1$  is other than {4-((2-methyl-4-quinolinyl)methoxy)phenyl}acetyl, {2-hydroxybenzoyl amino}benzenesulfonyl, 25 {4-fluorophenyl)methoxy}benzenesulfonyl, or {4-methoxyphenyl}carbamate}benzenesulfonyl;
- (ii) when rings B and C form tetrahydro-furo[2,3-c]pyridine, A is  $-C(O)NHOH$ , and U is  $SO_2$ , then Z is other than phenyl.

30

3. A compound according to Claim 2, wherein;

A is selected from:  $-C(O)NHOH$ , and  $-N(OH)CHO$ ;

5 U-X is  $SO_2$ ,  $C(O)$ , or  $C(O)CH_2$ ;

Z is phenyl substituted with 0-3  $R^b$  or pyridyl substituted with 0-3  $R^b$ ;

10  $U^a$  is absent or is selected from: O,  $NR^{a1}$ ,  $C(O)$ ,  $C(O)NR^{a1}$ ,  $S(O)_p$ , and  $S(O)_pNR^{a1}$ ;

$X^a$  is absent or is selected from:  $C_{1-4}$  alkylene,  $C_2$  alkenylene, and  $C_2$  alkynylene;

15

provided that  $U^a-X^a-Y^a$  forms a spacer of two or more atoms and is other than  $-CH=CH-$  or  $-C\equiv C-$ ;

20  $Z^a$  is a  $C_{5-6}$  carbocycle substituted with 0-3  $R^c$  or a 5-10 membered heteroaryl containing from 1-4 heteroatoms selected from the group consisting of N, O, and  $S(O)_p$  and substituted with 0-3  $R^c$ ;

25 provided that Z,  $U^a$ ,  $Y^a$ , and  $Z^a$  do not combine to form a N-N, N-O, O-N, O-O,  $S(O)_p-O$ ,  $O-S(O)_p$  or  $S(O)_p-S(O)_p$  group;

$R^a$ , at each occurrence, is independently selected from: H and  $C_{1-4}$  alkyl;

30

R<sup>a1</sup>, at each occurrence, is independently selected from: H,  
C<sub>1-4</sub> alkyl, phenyl and benzyl;

R<sup>b</sup>, at each occurrence, is independently selected from:  
5 C<sub>1-4</sub> alkyl, OR<sup>a</sup>, Cl, F, =O, NR<sup>a</sup>R<sup>a1</sup>, C(O)R<sup>a</sup>, C(O)OR<sup>a</sup>,  
C(O)NR<sup>a</sup>R<sup>a1</sup>, S(O)<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, S(O)<sub>p</sub>R<sup>a3</sup>, and CF<sub>3</sub>;

R<sup>c</sup>, at each occurrence, is independently selected from:  
C<sub>1-6</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>2-6</sub> alkynyl, OR<sup>a</sup>, Cl, F, Br,  
10 =O, NR<sup>a</sup>R<sup>a1</sup>, CF<sub>3</sub>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)OR<sup>a</sup>,  
(CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)NR<sup>a</sup>R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>S(O)<sub>p</sub>R<sup>a3</sup>,  
(CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>SO<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>, and phenyl; and

R<sup>5</sup>, at each occurrence, is selected from: C<sub>1-4</sub> alkyl  
15 substituted with 0-2 R<sup>b</sup>, and C<sub>1-4</sub> alkyl substituted  
with 0-2 R<sup>e</sup>;

provided that:

- (i) when rings B and C form tetrahydroisoquinoline  
20 and A is -C(O)NHOH, then R<sup>1</sup> is other than {4-  
{(2-methyl-4-quinolinyl)methoxy}phenyl}acetyl,  
{(2-hydroxybenzoyl)amino}benzenesulfonyl or  
{(4-fluorophenyl)methoxy}benzenesulfonyl;
- (ii) when rings B and C form tetrahydro-furo[2,3-  
25 c]pyridine, A is -C(O)NHOH, and U is SO<sub>2</sub>, then  
Z is other than phenyl.

4. A compound according to Claim 3, wherein;  
30 A is -C(O)NHOH;



Z is phenyl substituted with 0-1 R<sup>b</sup> or pyridyl substituted with 0-1 R<sup>b</sup>;

5 U<sup>a</sup> is absent or is O;

X<sup>a</sup> is absent or is CH<sub>2</sub> or CH<sub>2</sub>CH<sub>2</sub>;

Y<sup>a</sup> is absent or is O;

10

provided that U<sup>a</sup>-X<sup>a</sup>-Y<sup>a</sup> forms a spacer of two or more atoms, other than -CH=CH- or -C≡C-;

15 Z<sup>a</sup> is selected from: phenyl substituted with 0-3 R<sup>c</sup>,  
pyridyl substituted with 0-3 R<sup>c</sup>, and quinolinyl substituted with 0-3 R<sup>c</sup>;

provided that Z, U<sup>a</sup>, Y<sup>a</sup>, and Z<sup>a</sup> do not combine to form a N-N, N-O, O-N, or O-O group;

20

R<sup>a</sup>, at each occurrence, is independently selected from: H, CH<sub>3</sub>, and CH<sub>2</sub>CH<sub>3</sub>;

25 R<sup>a1</sup>, at each occurrence, is independently selected from: H, CH<sub>3</sub>, and CH<sub>2</sub>CH<sub>3</sub>;

R<sup>a2</sup>, at each occurrence, is independently selected from: H, CH<sub>3</sub>, and CH<sub>2</sub>CH<sub>3</sub>;

30 R<sup>c</sup>, at each occurrence, is independently selected from: C<sub>1-6</sub> alkyl, C<sub>2-6</sub> alkenyl, C<sub>2-6</sub> alkynyl, OR<sup>a</sup>, Cl, F, Br,

=O, NR<sup>a</sup>R<sup>a1</sup>, CF<sub>3</sub>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)OR<sup>a</sup>,  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>C(O)NR<sup>a</sup>R<sup>a1</sup>, (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>S(O)<sub>p</sub>R<sup>a3</sup>, and  
 (CR<sup>a</sup>R<sup>a1</sup>)<sub>n</sub>SO<sub>2</sub>NR<sup>a</sup>R<sup>a1</sup>;

5 r, at each occurrence, is selected from 0, 1, 2, and 3;  
 and,

n, at each occurrence, is selected from 0, 1, 2, and 3;

10 provided that:

- (i) when rings B and C form tetrahydroisoquinoline  
 and A is -C(O)NHOH, then R<sup>1</sup> is other than {4-  
 ((2-methyl-4-quinolinyl)methoxy)phenyl}acetyl  
 or {(4-fluorophenyl)methoxy}benzenesulfonyl;
- 15 (ii) when rings B and C form tetrahydro-furo[2,3-  
 c]pyridine, A is -C(O)NHOH, and U is SO<sub>2</sub>, then  
 Z is other than phenyl.

20 5. A compound according to Claim 1, wherein the compound  
 is selected from the group:

N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
 acetyl)-5,6,7,8-tetrahydro-1,6-naphthyridine-7-  
 25 carboxamide;

N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
 sulfonyl)-5,6,7,8-tetrahydro-1,6-naphthyridine-7-  
 carboxamide;

30

N-hydroxy-7-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}

acetyl)-5,6,7,8-tetrahydro-1,7-naphthyridine-6-carboxamide;

5 N-hydroxy-7-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
sulfonyl)-5,6,7,8-tetrahydro-1,7-naphthyridine-6-carboxamide;

10 N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
acetyl)-5,6,7,8-tetrahydropyrido[3,4-b]-pyrazine-7-carboxamide;

15 N-hydroxy-6-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
sulfonyl)-5,6,7,8-tetrahydropyrido[3,4-b]pyrazine-7-carboxamide;

N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
acetyl)-4,5,6,7-tetrahydro[1,3]oxazolo[5,4-c]pyridine-6-carboxamide;

20 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
sulfonyl)-4,5,6,7-tetrahydro[1,3]oxazolo[5,4-c]pyridine-6-carboxamide;

25 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
acetyl)-4,5,6,7-tetrahydro[1,3]thiazolo[4,5-c]pyridine-6-carboxamide; and

30 N-hydroxy-5-({4-[(2-methyl-4-quinolinyl)methoxy]phenyl}  
sulfonyl)-4,5,6,7-tetrahydro[1,3]thiazolo[4,5-c]pyridine-6-carboxamide;

or a pharmaceutically acceptable salt form thereof.

6. A pharmaceutical composition, comprising: a  
pharmaceutically acceptable carrier and a therapeutically  
5 effective amount of a compound according to Claim 1, 2, 3,  
4, or 5 or a pharmaceutically acceptable salt form thereof.

7. A method for treating an inflammatory disorder,  
10 comprising: administering to a patient in need thereof a  
therapeutically effective amount of a compound according to  
Claim 1, 2, 3, 4, or 5 or a pharmaceutically acceptable  
salt form thereof.

15  
8. A method comprising: administering a compound  
according to Claim 1, 2, 3, 4, or 5 or a pharmaceutically  
acceptable salt form thereof, in an amount effective to  
treat a condition or disease mediated by MMPs, TACE, or a  
20 combination thereof.

9. A method of treating a condition or disease mediated by  
MMPs, TACE, aggrecanase, or a combination thereof in a  
25 mammal, comprising: administering to the mammal in need of  
such treatment a therapeutically effective amount of a  
compound according to Claim 1, 2, 3, 4, or 5 or a  
pharmaceutically acceptable salt form thereof.

30  
10. A method of treating according to Claim 9, wherein the  
disease or condition is selected from acute infection,

acute phase response, age related macular degeneration,  
alcoholic liver disease, allergy, allergic asthma,  
anorexia, aneurism, aortic aneurism, asthma,  
atherosclerosis, atopic dermatitis, autoimmune disease,  
5 autoimmune hepatitis, Bechet's disease, cachexia, calcium  
pyrophosphate dihydrate deposition disease, cardiovascular  
effects, chronic fatigue syndrome, chronic obstruction  
pulmonary disease, coagulation, congestive heart failure,  
corneal ulceration, Crohn's disease, enteropathic  
10 arthropathy, Felty's syndrome, fever, fibromyalgia  
syndrome, fibrotic disease, gingivitis, glucocorticoid  
withdrawal syndrome, gout, graft versus host disease,  
hemorrhage, HIV infection, hyperoxic alveolar injury,  
infectious arthritis, inflammation, intermittent  
15 hydrarthrosis, Lyme disease, meningitis, multiple  
sclerosis, myasthenia gravis, mycobacterial infection,  
neovascular glaucoma, osteoarthritis, pelvic inflammatory  
disease, periodontitis, polymyositis/dermatomyositis, post-  
ischaemic reperfusion injury, post-radiation asthenia,  
20 psoriasis, psoriatic arthritis, pulmonary emphysema,  
pyoderma gangrenosum, relapsing polychondritis, Reiter's  
syndrome, rheumatic fever, rheumatoid arthritis,  
sarcoidosis, scleroderma, sepsis syndrome, Still's disease,  
shock, Sjogren's syndrome, skin inflammatory diseases,  
25 solid tumor growth and tumor invasion by secondary  
metastases, spondylitis, stroke, systemic lupus  
erythematosus, ulcerative colitis, uveitis, vasculitis, and  
Wegener's granulomatosis.

30

11. A compound of Claim 1, 2, 3, 4, or 5 or a pharmaceutically acceptable salt form thereof for use in therapy.

5

12. Use of a compound of Claim 1, 2, 3, 4, or 5 or a pharmaceutically acceptable salt form thereof for the manufacture of a medicament for the treatment of a condition or disease mediated by MMPs, TACE, aggrecanase,  
10 or a combination thereof.

13. A method for treating inflammatory disorders, comprising: administering, to a host in need of such  
15 treatment, a therapeutically effective amount of a compound of Claim 1, 2, 3, 4, or 5 or a pharmaceutically acceptable salt form thereof, in combination with one or more additional anti-inflammatory agents selected from selective COX-2 inhibitors, interleukin-1 antagonists, dihydroorotate  
20 synthase inhibitors, p38 MAP kinase inhibitors, TNF- $\alpha$  inhibitors, TNF- $\alpha$  sequestration agents, and methotrexate.

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(54) Title: BICYCLIC HYDROXAMATES AS INHIBITORS OF MATRIX METALLOPROTEINASES AND/OR TNF- $\alpha$ (A) CONVERTING ENZYME (TACE)

(57) Abstract: The present application describes to novel bicyclic hydroxamates derivatives of formula I: or pharmaceutically acceptable salt or prodrug forms thereof, wherein A, B, B<sup>1</sup>, B<sup>2</sup>, R<sup>1</sup>, and C are defined in the present specification, which are useful as inhibitors of matrix metalloproteinases (MMP), TNF- $\alpha$  converting enzyme (TACE), aggrecanase, or a combination thereof.



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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/26018

**A. CLASSIFICATION OF SUBJECT MATTER**IPC(7) : C07D 498/06, 513/06; A61K 31/4375, 31/4985  
US CL : 514/249, 300, 301, 302; 544/236; 546/122

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**Minimum documentation searched (classification system followed by classification symbols)  
U.S. : 514/249, 300, 301, 302; 544/236; 546/122

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Continuation Sheet**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,866,587 A (DE NANTEUIL et al.) 02 February 1999 (02-02-1999), column 2.	5-11, 13
A	MATTER et al. Quantitative Structure-Activity Relationship of Human Neutrophil Collagenase (MMP-8) Inhibitors Using Comparative Molecular Field analysis and X-ray Structure Analysis. Journal of Medicinal Chemistry. 1999, Vol. 42, No. 11, pages 1908-1920, especially page 1909.	5-11, 13
A	MATTER et al. Affinity and Selectivity of Matrix Metalloproteinase Inhibitors: A Chemometrical study from the Perspective of Ligands and Proteins. Journal of Medicinal Chemistry. 1999, Vol. 42, No. 22, pages 4506-4523, especially page 4508.	5-11, 13
A,I	US 6,339,092 A (DE NANTEUIL et al.) 15 January 2002 (15-01-2002), columns 1 and 2.	5-11, 13

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

## \* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/26018

## Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claim Nos.: 1-4  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:  
Please See Continuation Sheet
3. ☐ Claim Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐

The additional search fees were accompanied by the applicant's protest.

☐

No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

PCT/US02/26018

### Continuation of Box I Reason 2:

In these claims, the numerous variables (e.g. B, B1, B2, A, R1, C, R5, R2, p, R3, R4, U, X, Y, Z, Ua, Xa, Ya, Za, Ra1, Rc, Rb, Ra, Ra3, Rc1 R5, R6, Re, R7, R7a, R8, R9, Rf, n, r, etc.) and their voluminous complex meanings and their seemingly endless permutations and combinations and the numerous provisos, make it virtually impossible to determine the full scope and complete meaning of the claimed subject matter. As presented, the claimed subject matter cannot be regarded as being a clear and concise description for which protection is sought and as such the listed claims do not comply with the requirements of PCT article 6. Thus it is impossible to carry out a meaningful search on same. A search will be made on the first discernable invention, which is the compounds of claim 5 and the products and methods of claims 6-11 and 13 within the scope of the compounds of claim 5.

### Continuation of B. FIELDS SEARCHED Item 3:

CAS ONLINE  
STN structure search